



Fisheries Applications of Satellite Data

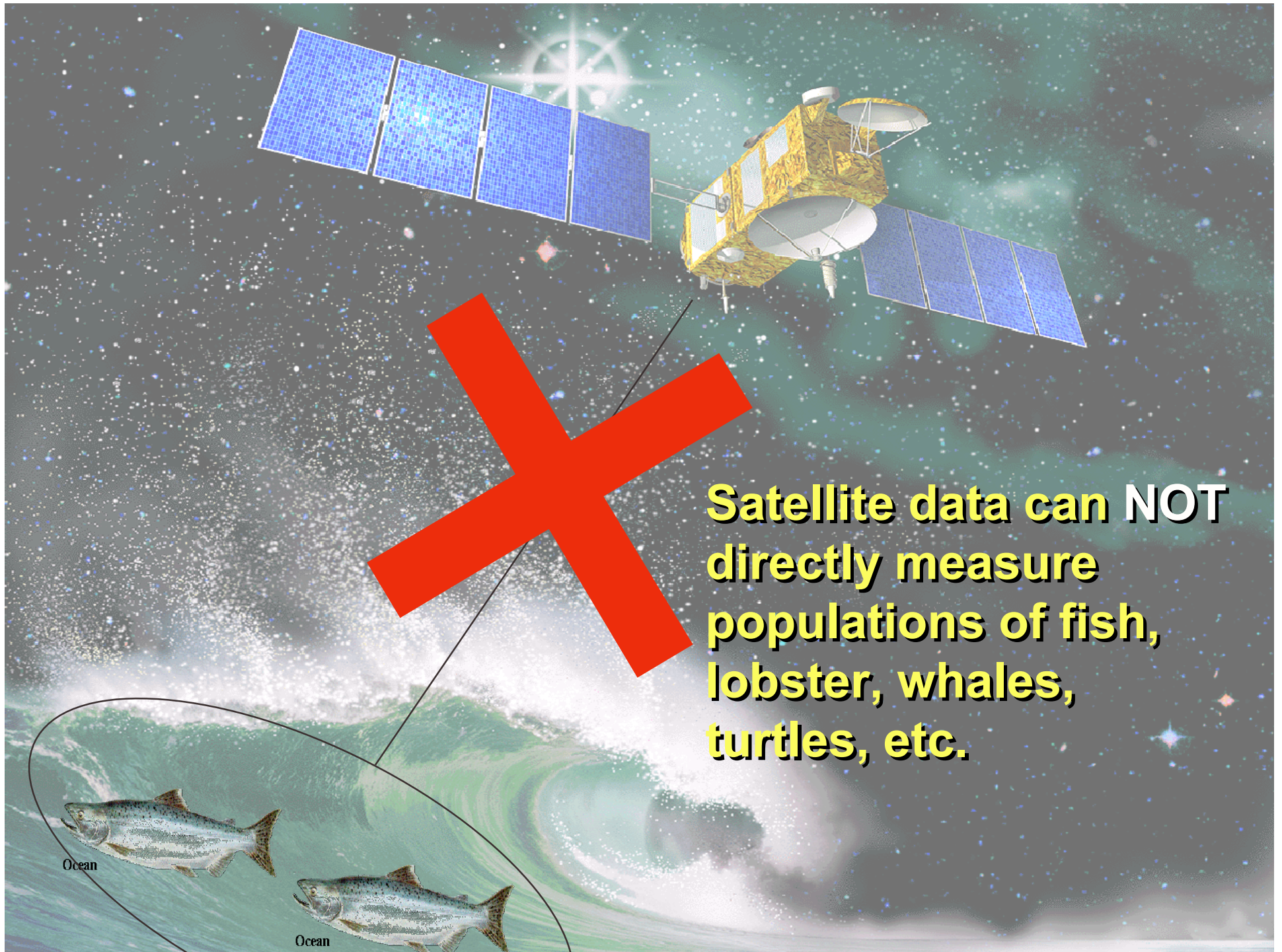
Cara Wilson

**NOAA/NMFS/SWFSC
Environmental Research Division (ERD)**

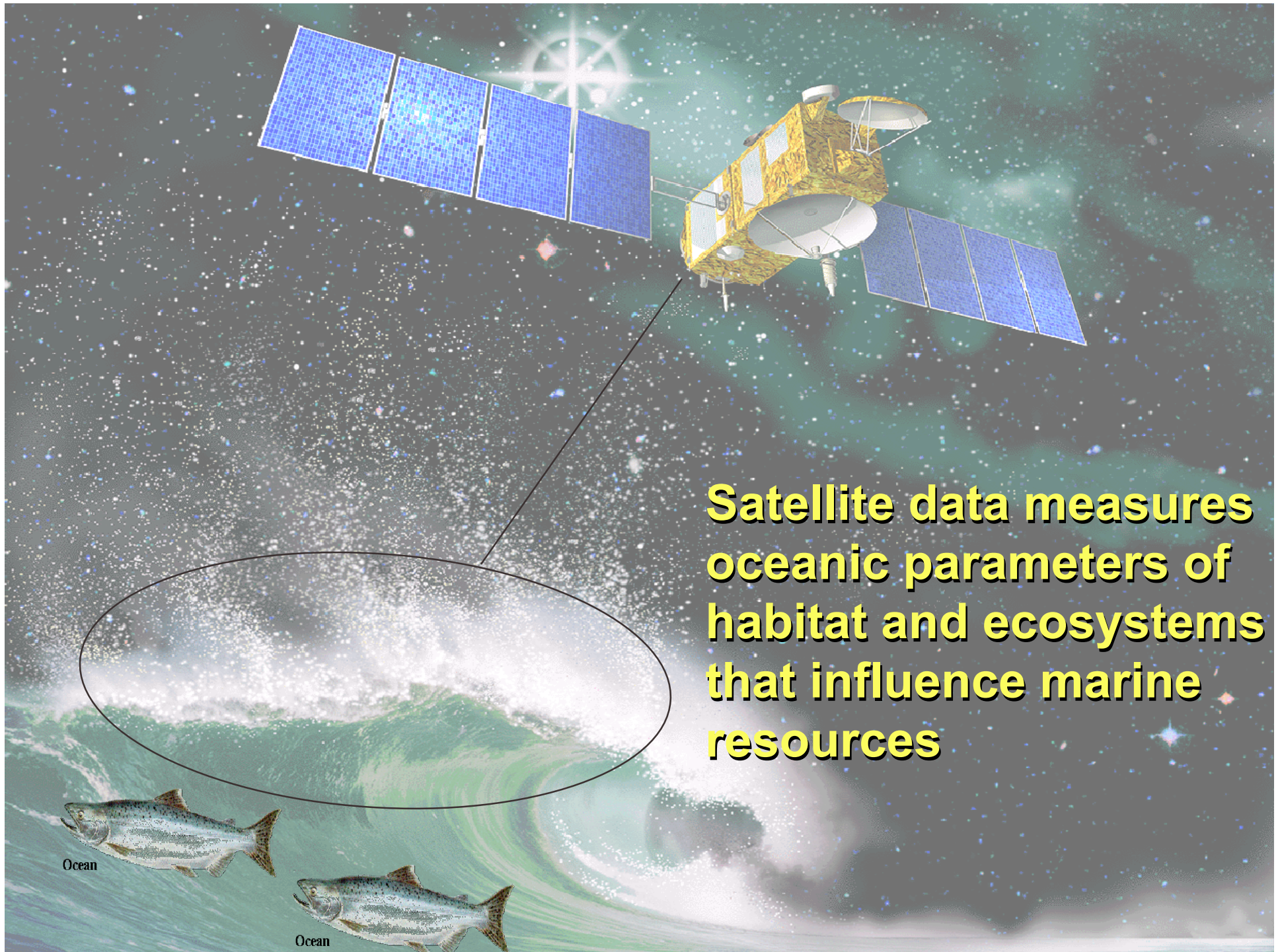
**Coastal Ocean Applications and Science Team (COAST)
3rd meeting, September 7-8, 2005**

Ocean

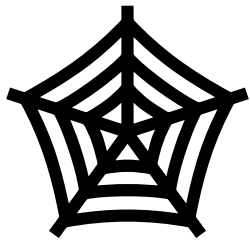
Ocean



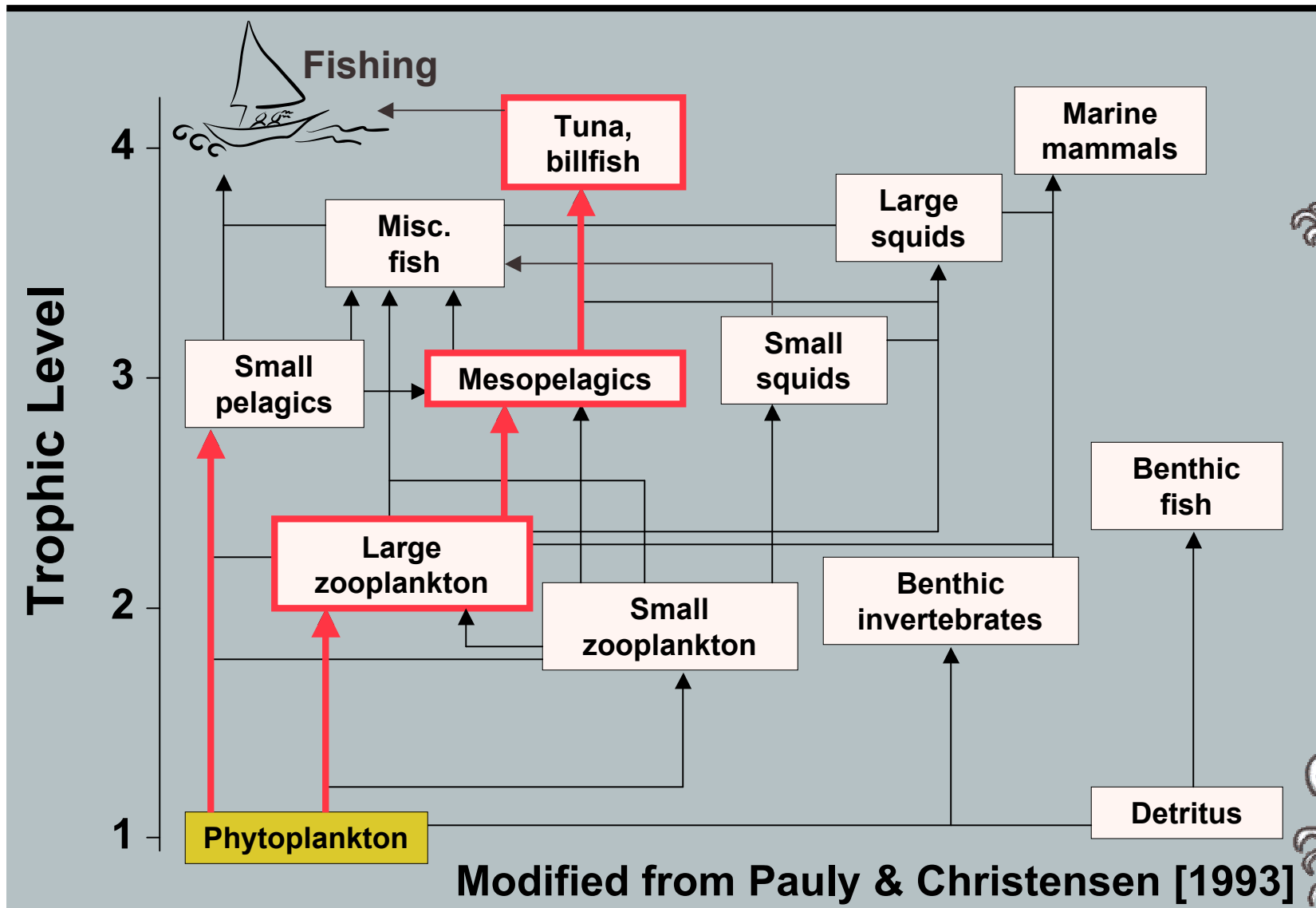
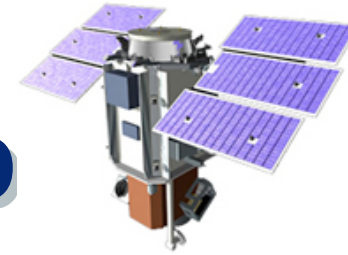
**Satellite data can NOT
directly measure
populations of fish,
lobster, whales,
turtles, etc.**



**Satellite data measures
oceanic parameters of
habitat and ecosystems
that influence marine
resources**



Oceanic Food Web

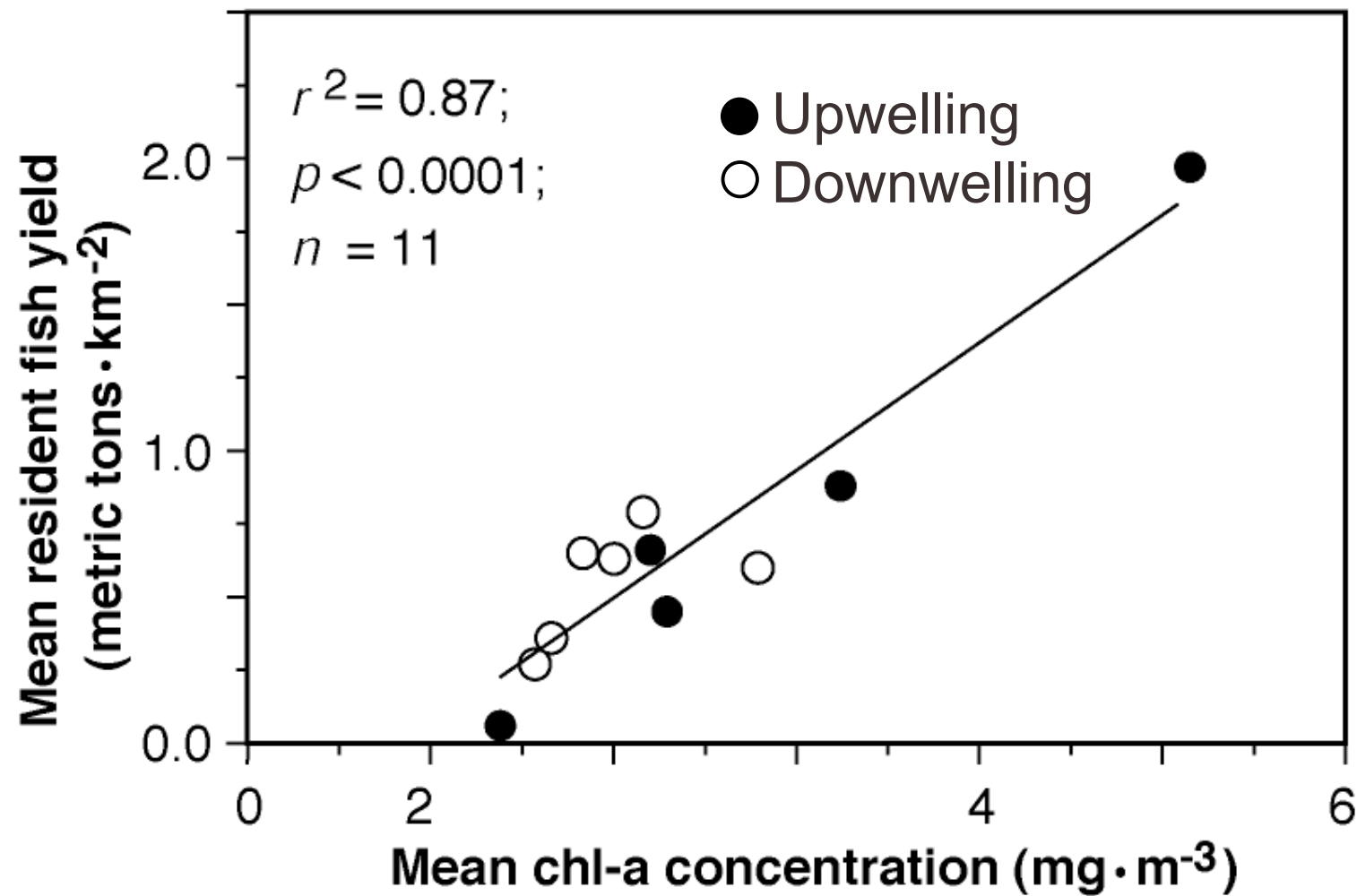




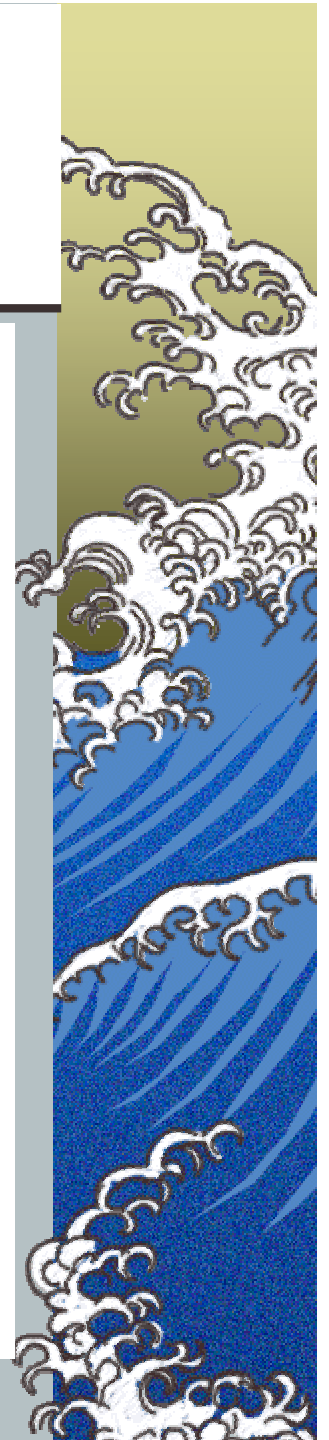
Ware & Thomson [Science, 2003]



Linkages



Ware & Thomson [Science, 2003]

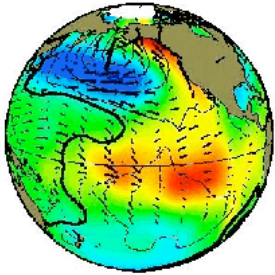




Temporal Events Important to Marine Resources

- ▲ Upwelling
- ▲ Harmful Algae Blooms (HABs)
- ▲ Oil Spills
- ▲ Seasonal Transitions
- ▲ El Niño events
- ▲ Regime Shifts (i.e. PDO)
- ▲ Global Climate Change





Regimes shifts

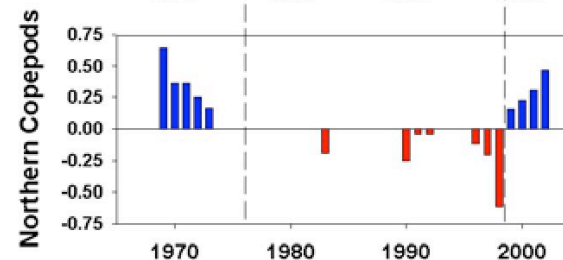
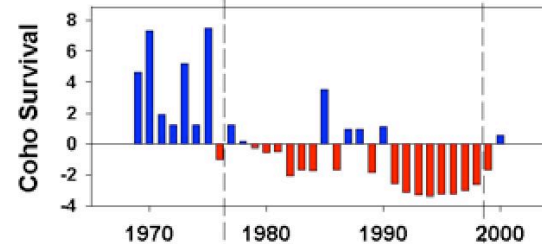
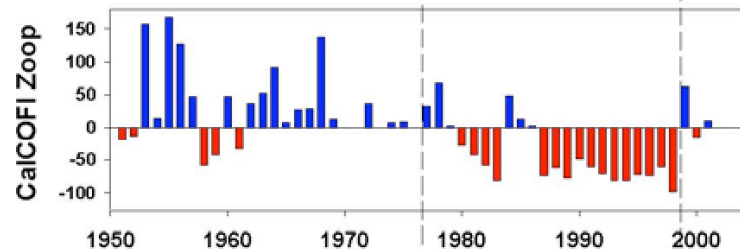
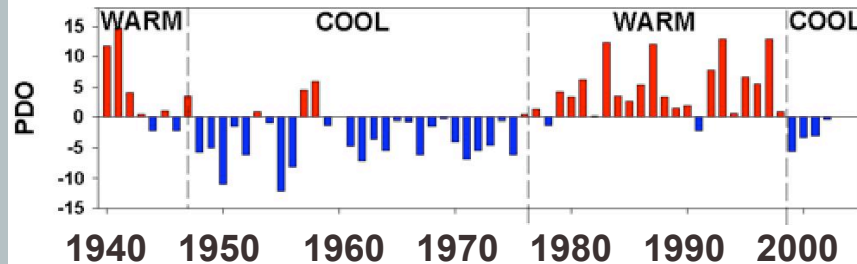
PDO

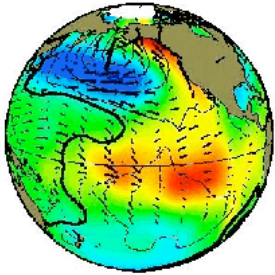
**Zooplankton
(CalCOFI)**

Coho Survival

Copepods

*Peterson & Schwing [GRL, 2003]
(NOAA/NMFS - NWFSC & SWFSC)*





Regimes shifts

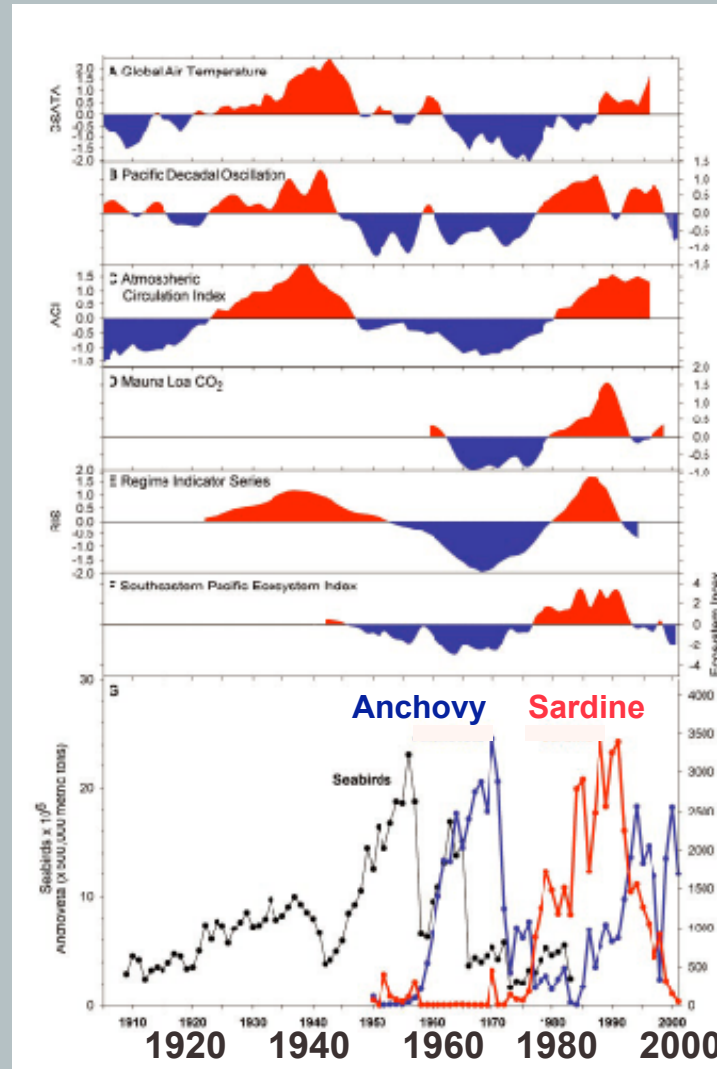
Global Air Temperature

PDO

Atm. Circulation

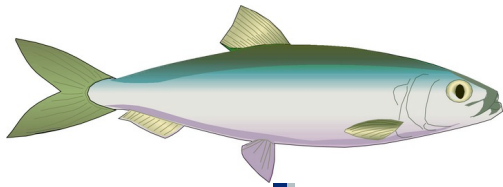
CO2

*Long-term Climate
Quality Records
essential for
Fisheries needs!*



Chavez et al. [Science, 2003]



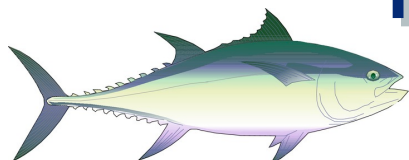


Ocean Features

Important to Marine Resources

- ▶ Ocean 'fronts', boundaries, 'edges'
- ▶ River plumes
- ▶ Coastal regions
- ▶ Mesoscale circulation patterns, e.g., eddies, meanders, 'loops'
- ▶ Convergence zones
- ▶ Subsurface thermal structure (MLD, thermocline)
- ▶ Ocean surface winds
- ▶ Ocean currents
- ▶ Wave heights





Fisheries Relevant Applications of 'Satellite' Data (RSD)

- *Benthic habitat mapping*
- *Land cover changes*
- *Oil spill detection and monitoring*
- *Distribution of tagged Living Marine Resources (LMR)*
- *Enforcement (VMS)*
- ***Harmful Algal Bloom (HAB) detection***
- *Coral bleaching detection & monitoring*
- ***Optimize planning of fisheries research cruises***
- ***Policy & Regulation***
- *LMR strandings and mortalities*
- ***Pelagic habitat assessment***
- *Population analysis of LMRs*

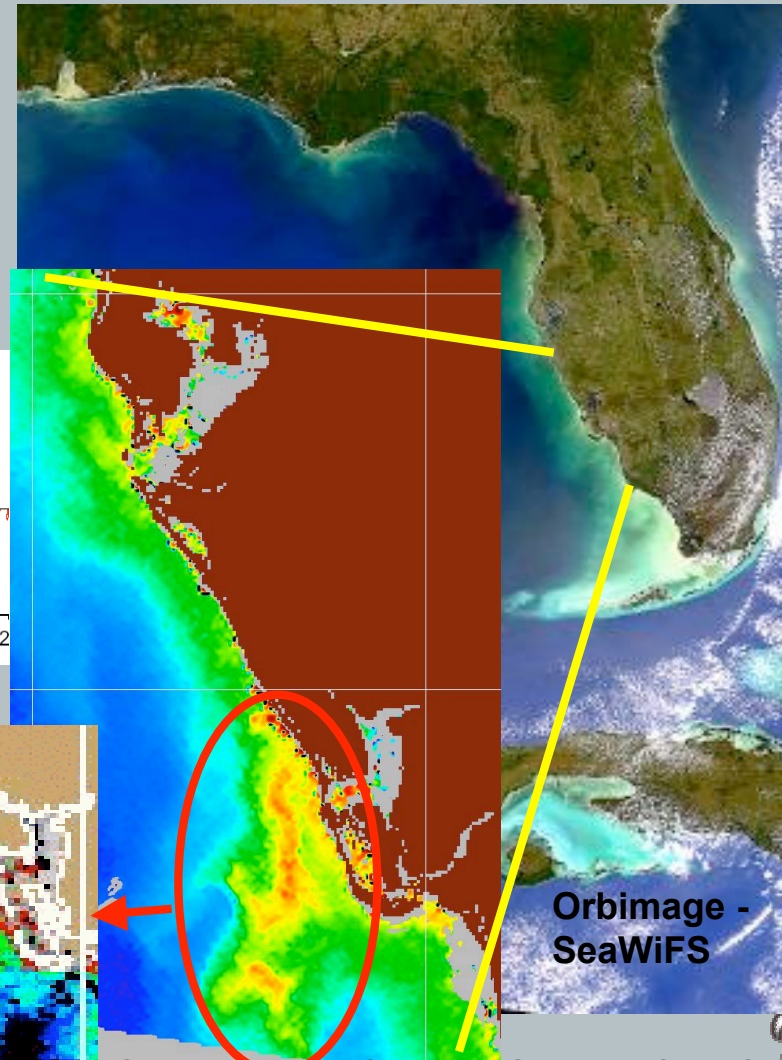
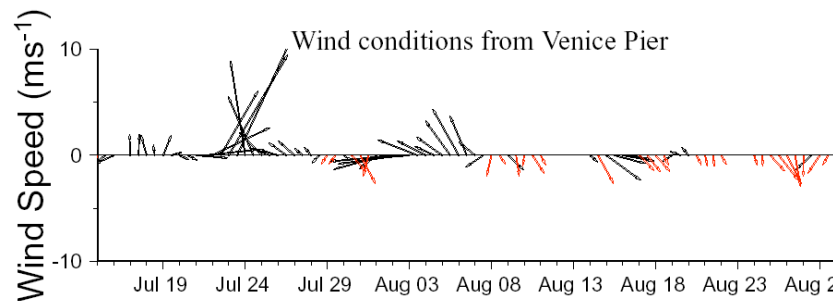




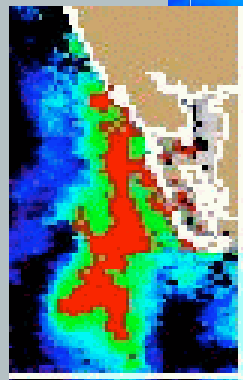
Harmful Algal Bloom (HAB) detection

NOAA National Ocean Service

Operational Monitoring and Forecasting of HABs in the Gulf of Mexico



HABs can result in shellfish bed closures, and can cause death to fish and marine mammals



Courtesy of Rick Stumpf, NOS

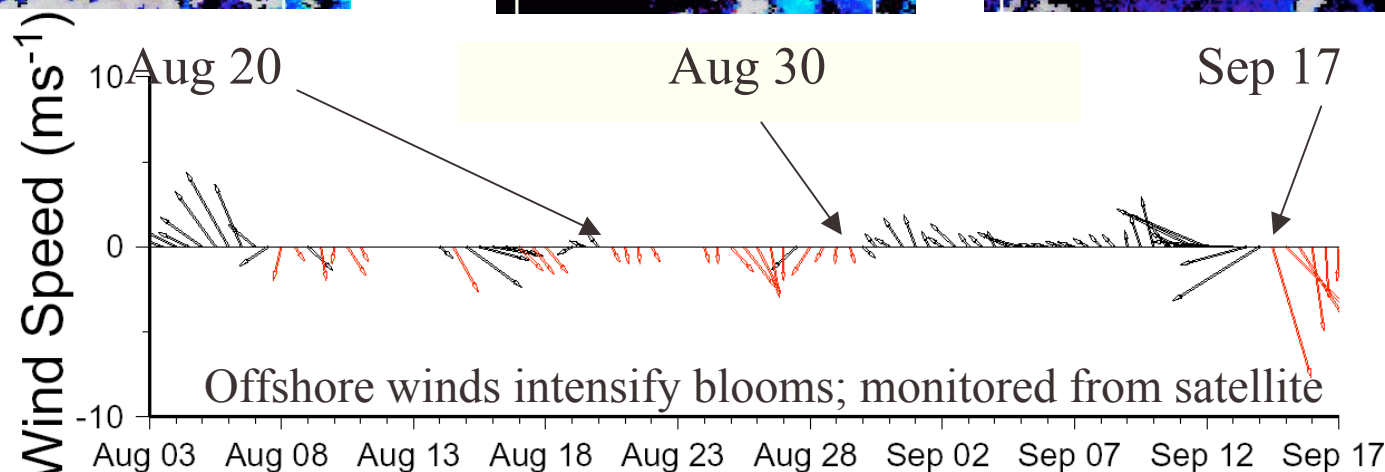
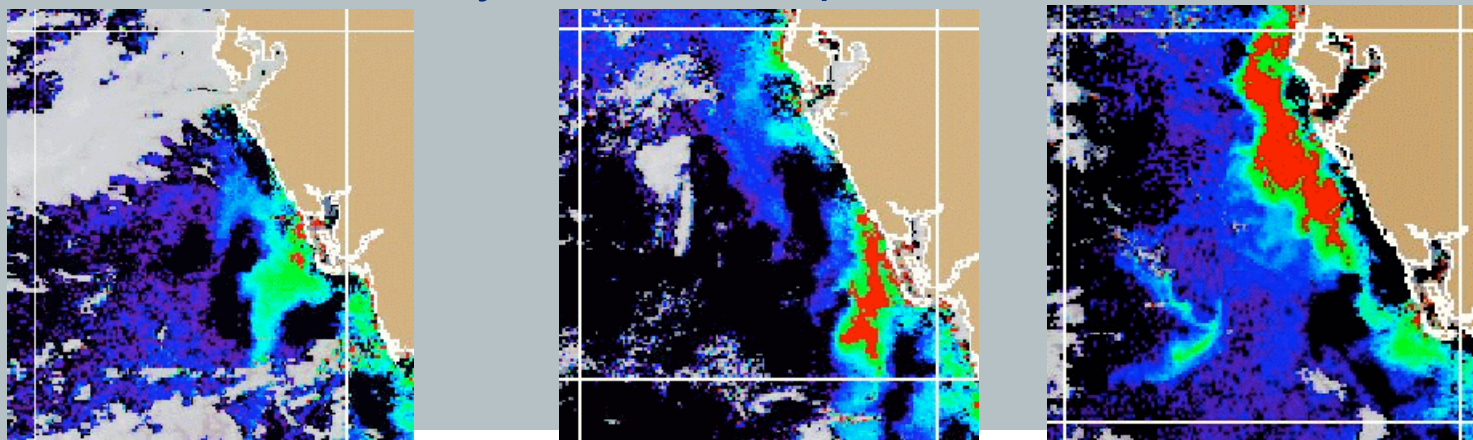




Harmful Algal Bloom (HAB) detection

HAB initiation and intensification with upwelling
HAB-flags (Red is HAB, green is weaker HAB)

Courtesy of Rick Stumpf, NOAA NOS



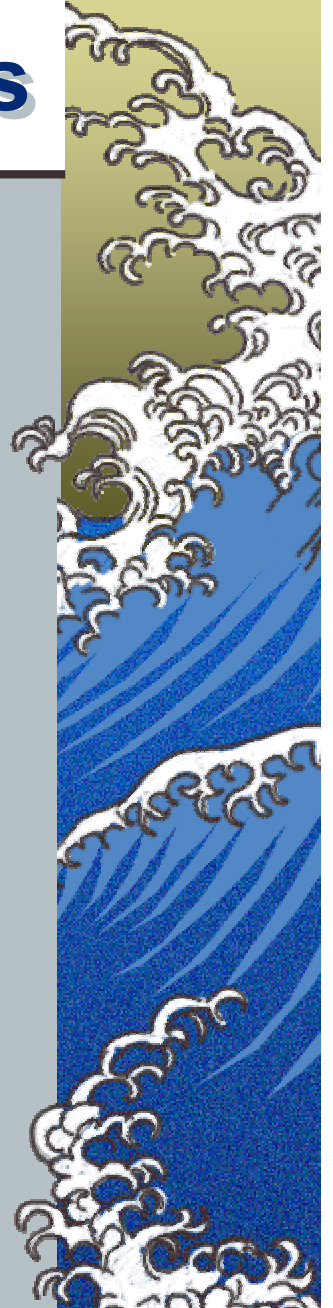


Optimize planning of fisheries research cruises

Ghostnet Program

Detection and tracking of marine debris in the North Pacific ocean using satellite and airborne remote sensing technologies

- Airborne Technologies Inc.
- NOAA Research/ETL
- NOAA Satellites and Information/ORA
- NOAA Fisheries/SWFSC/ERD (*Dave Foley*)





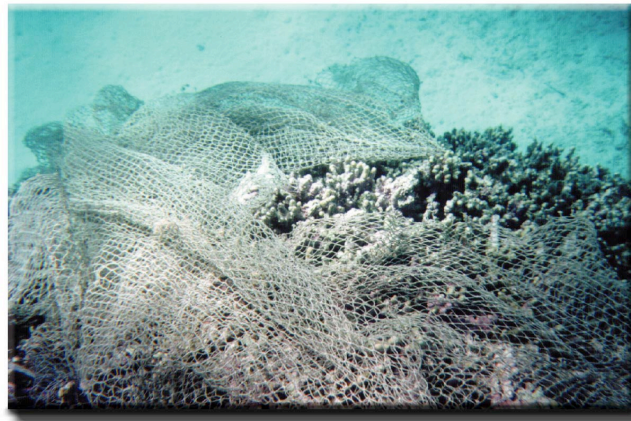
Ghostnet Program - Rationale

Minimize navigation hazards
Reduce wasteful "Ghost fishing"



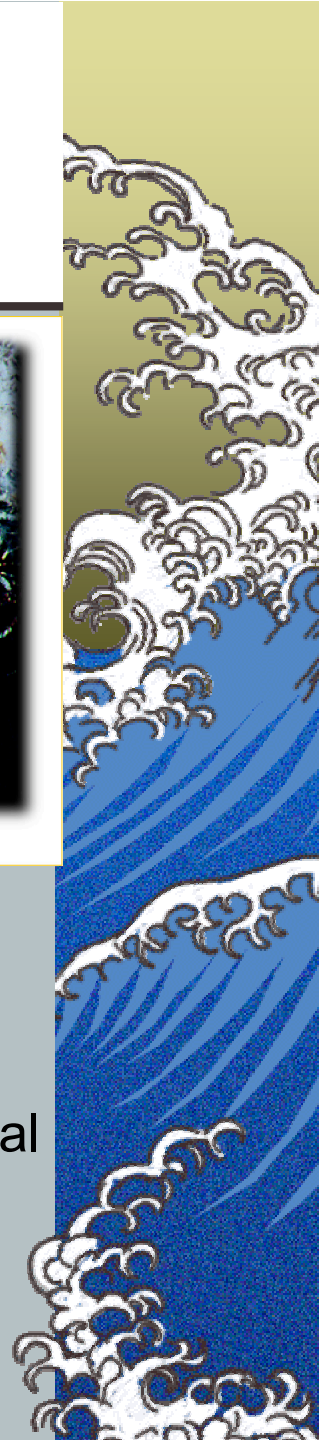
Endangered Hawaiian Monk seal trapped in marine debris

Protect endangered species



Derelict fishing net anchored on coral

Maintain healthy coral
reef ecosystems





Ghostnet Approach

Satellite data to identify convergence zones

- Infer with Ocean Color, SST, vector winds
- Observe with specially tasked SAR

Aircraft to confirm presence of debris

- Designating “hot spots”
- Deploy drifting buoys to track debris fields*

Interdiction with ships already on station*

- Possible use of helicopter to optimize collection

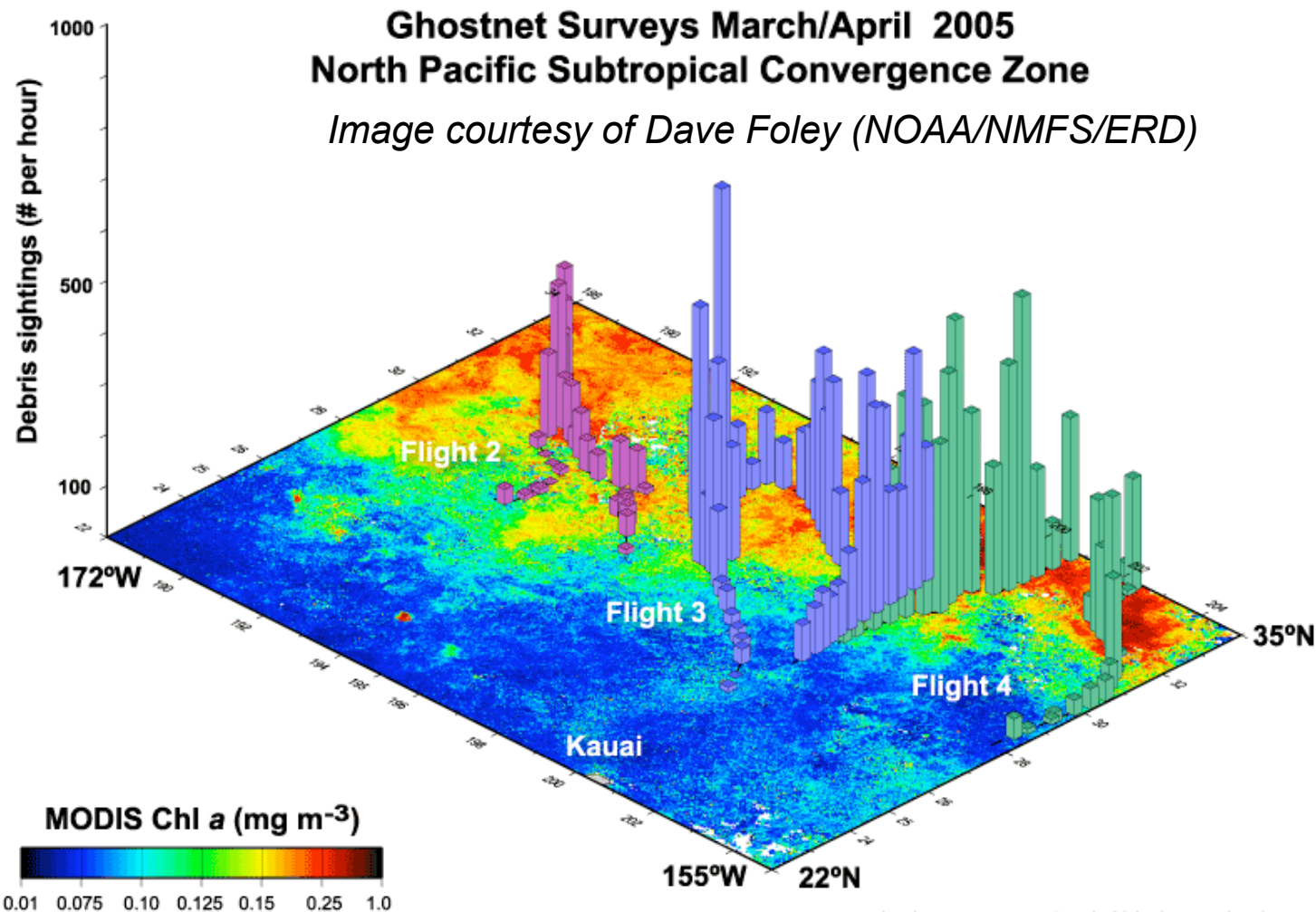
* Planned for FY06



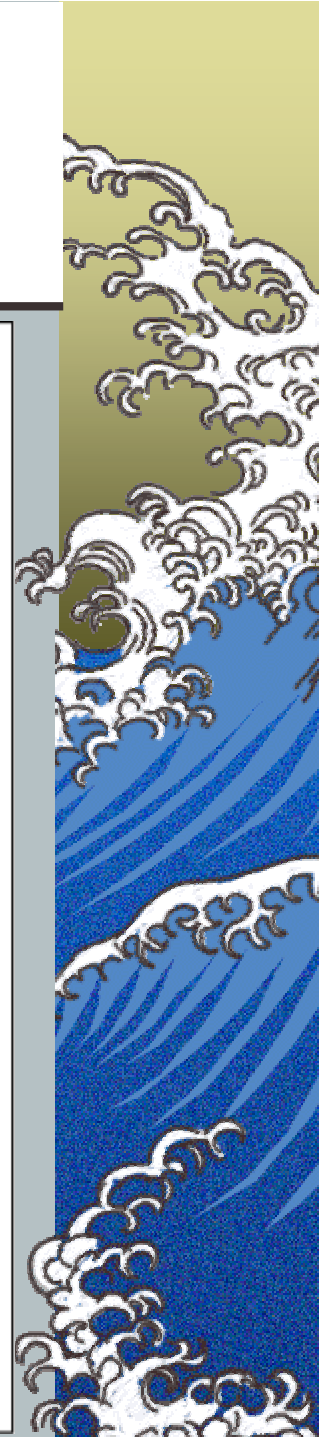


Ghostnet

Preliminary Results

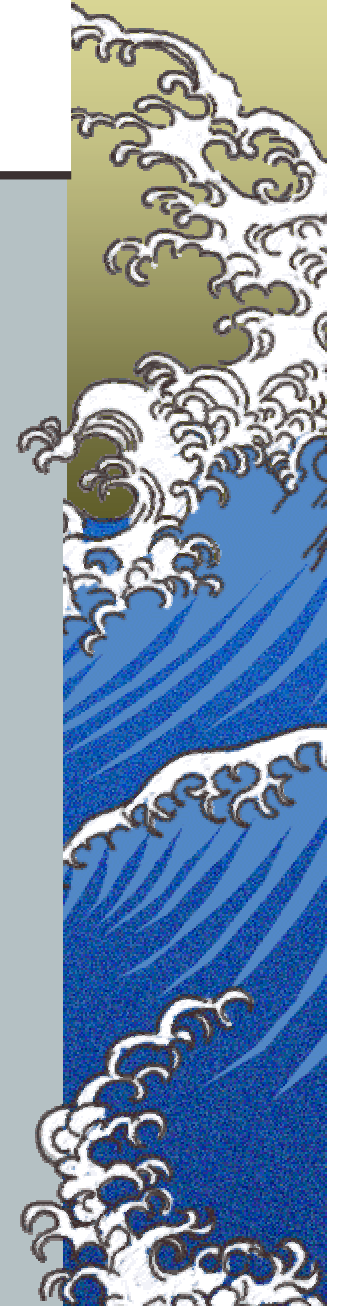
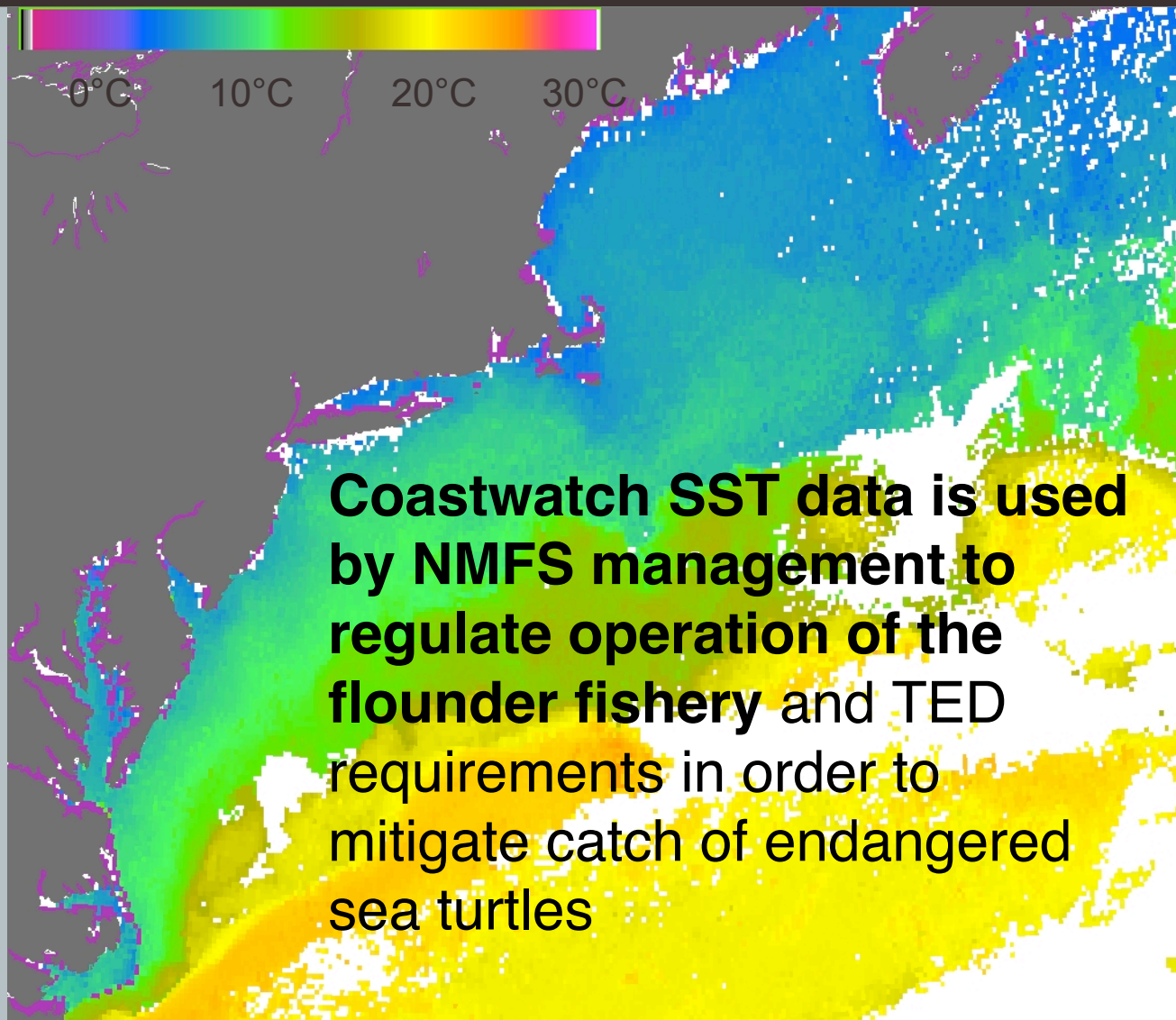


MODIS data courtesy of NASA/GSFC and NOAA/PFEL



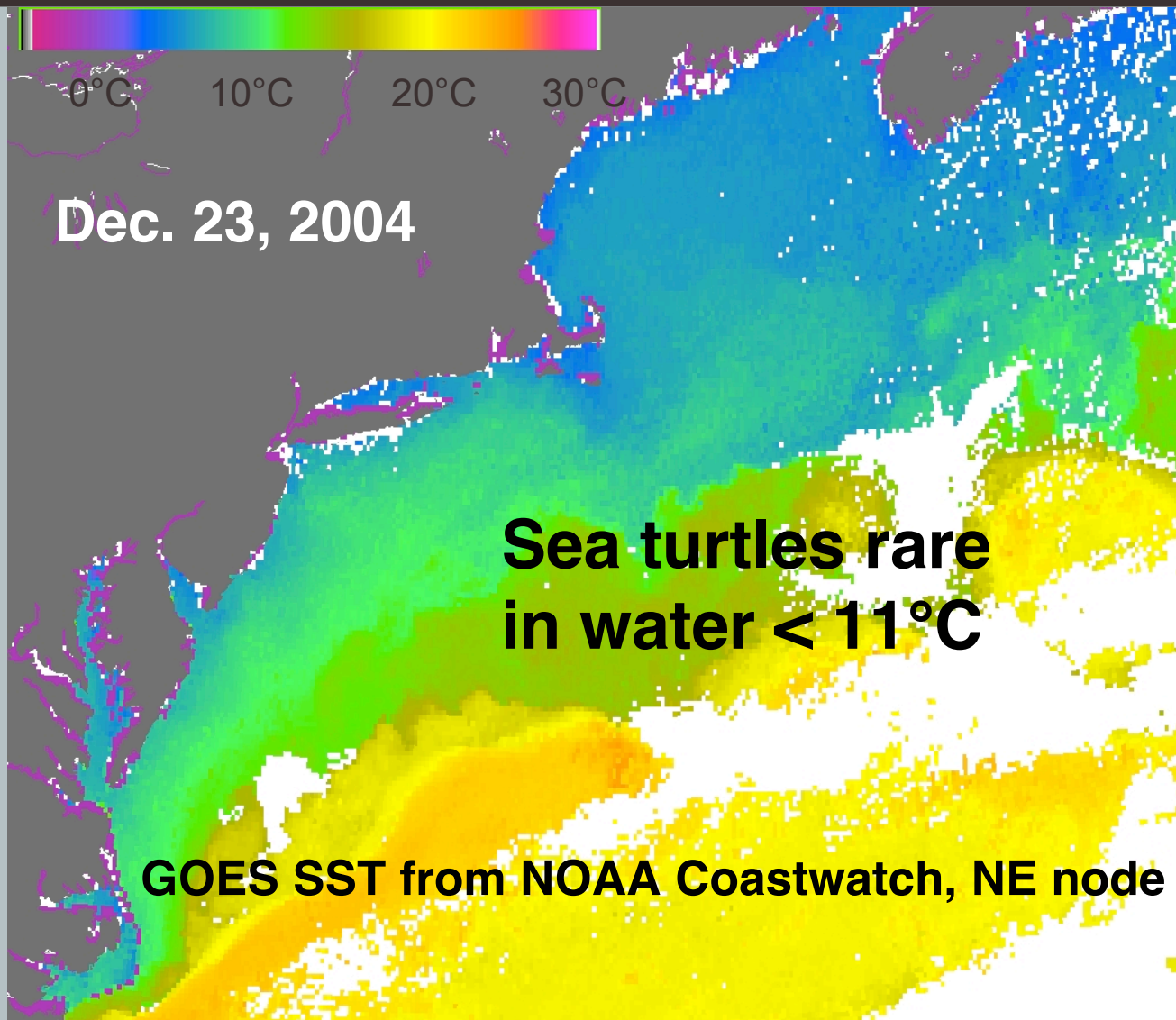


Policy & Regulation



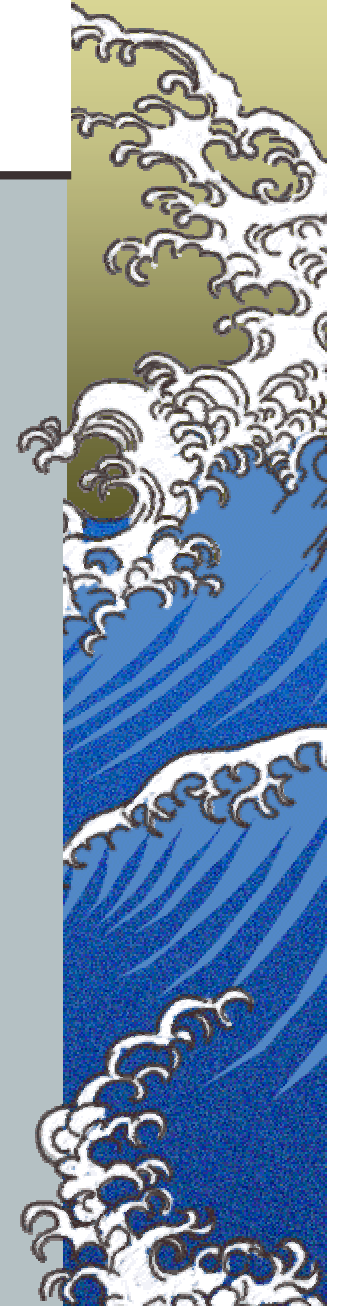
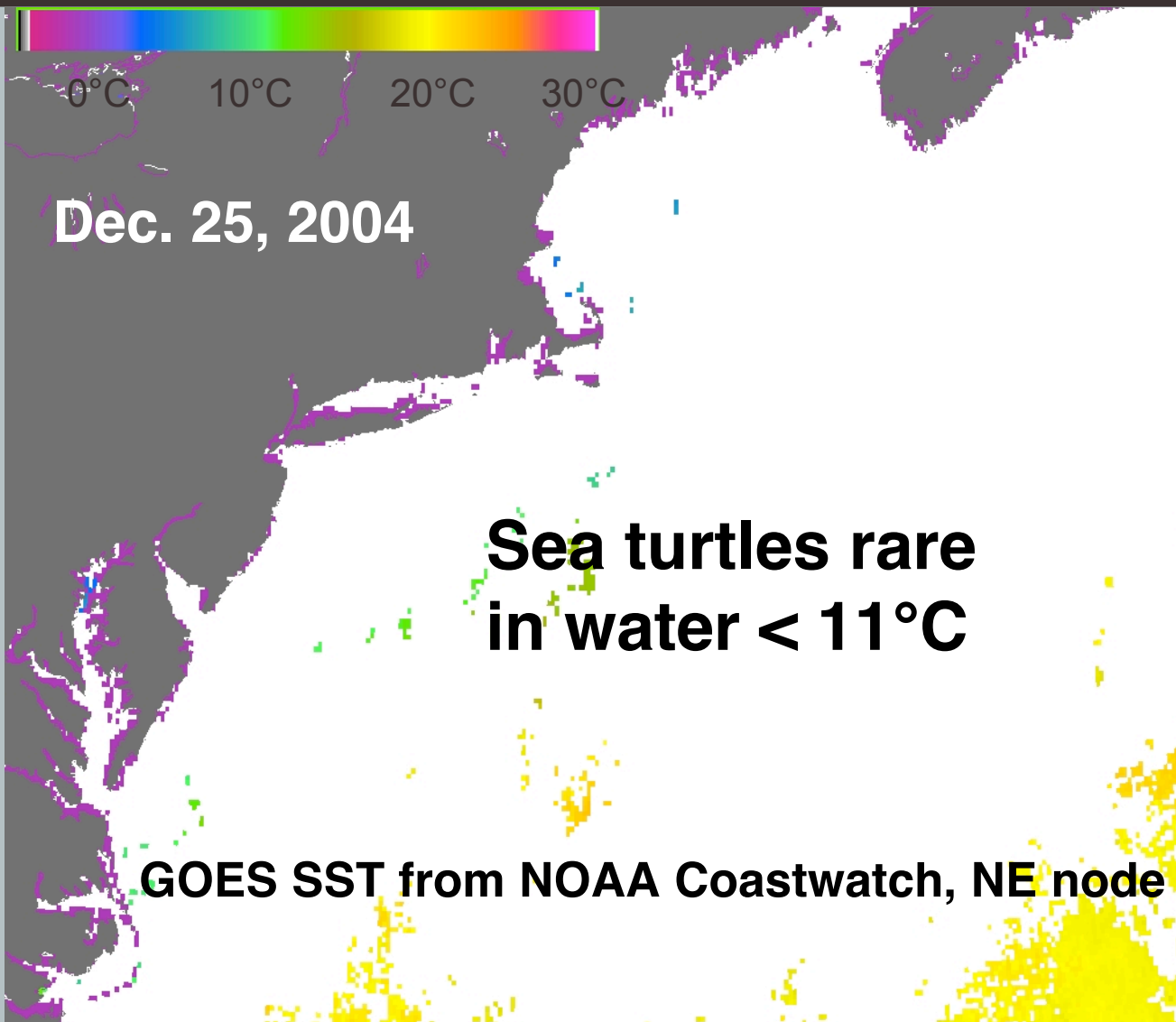


Policy & Regulation



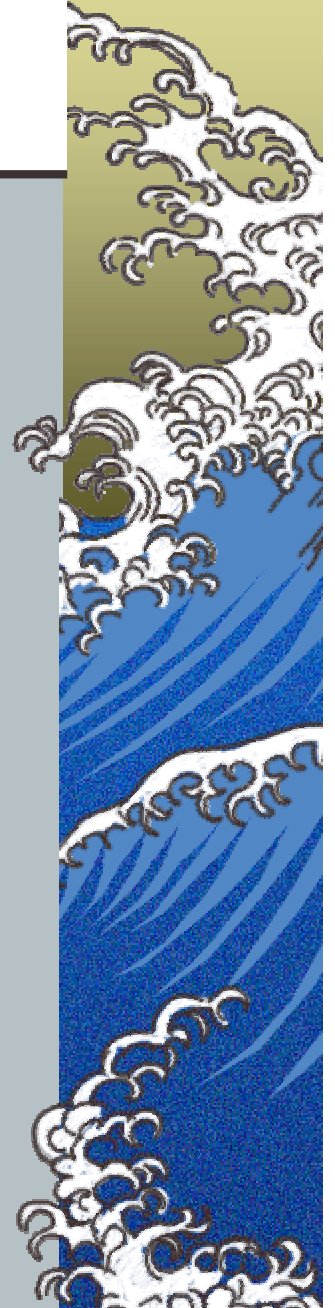


Policy & Regulation



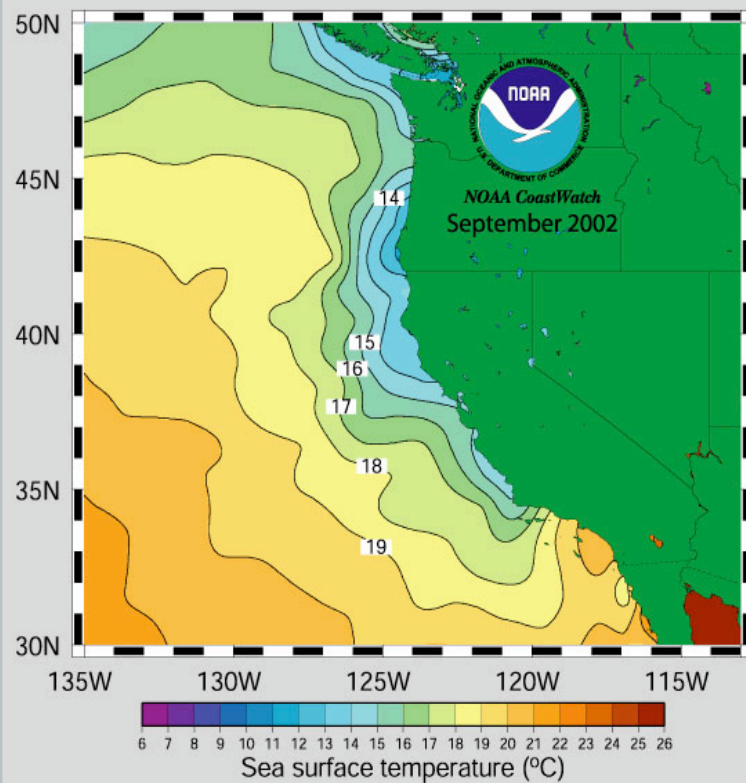
El Niño Watch

- Maintained by NOAA's west coast CoastWatch node
- Special SST data product prepared for NMFS SWR fishery managers, mandated for use in managing California fishery for large pelagic fishes
- First use of satellite data in management of West Coast Fisheries
- Generated monthly
- Complementary images of Chlorophyll and Wind Stress Curl now provided

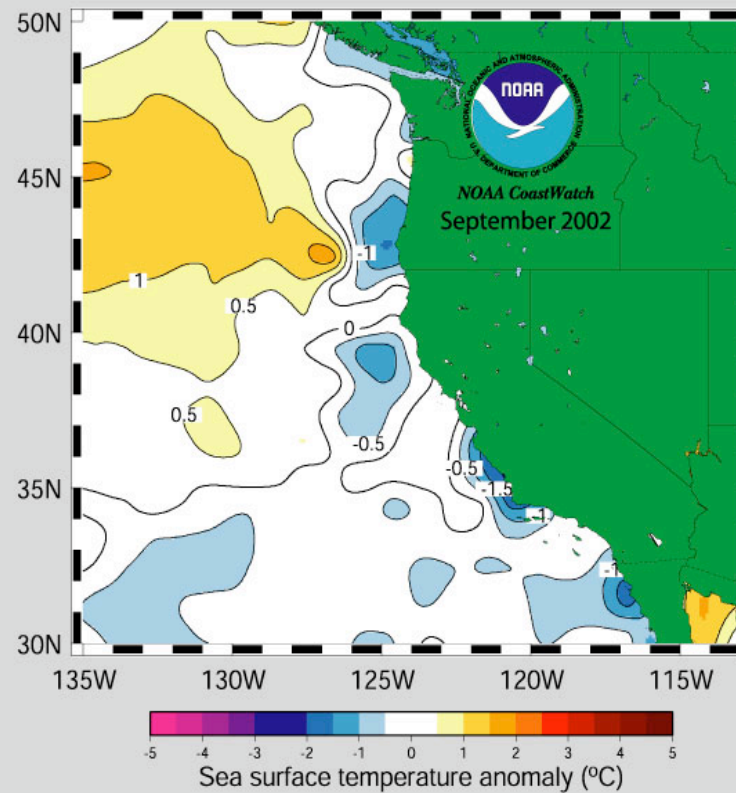


El Niño Watch

SST



SST Anomaly



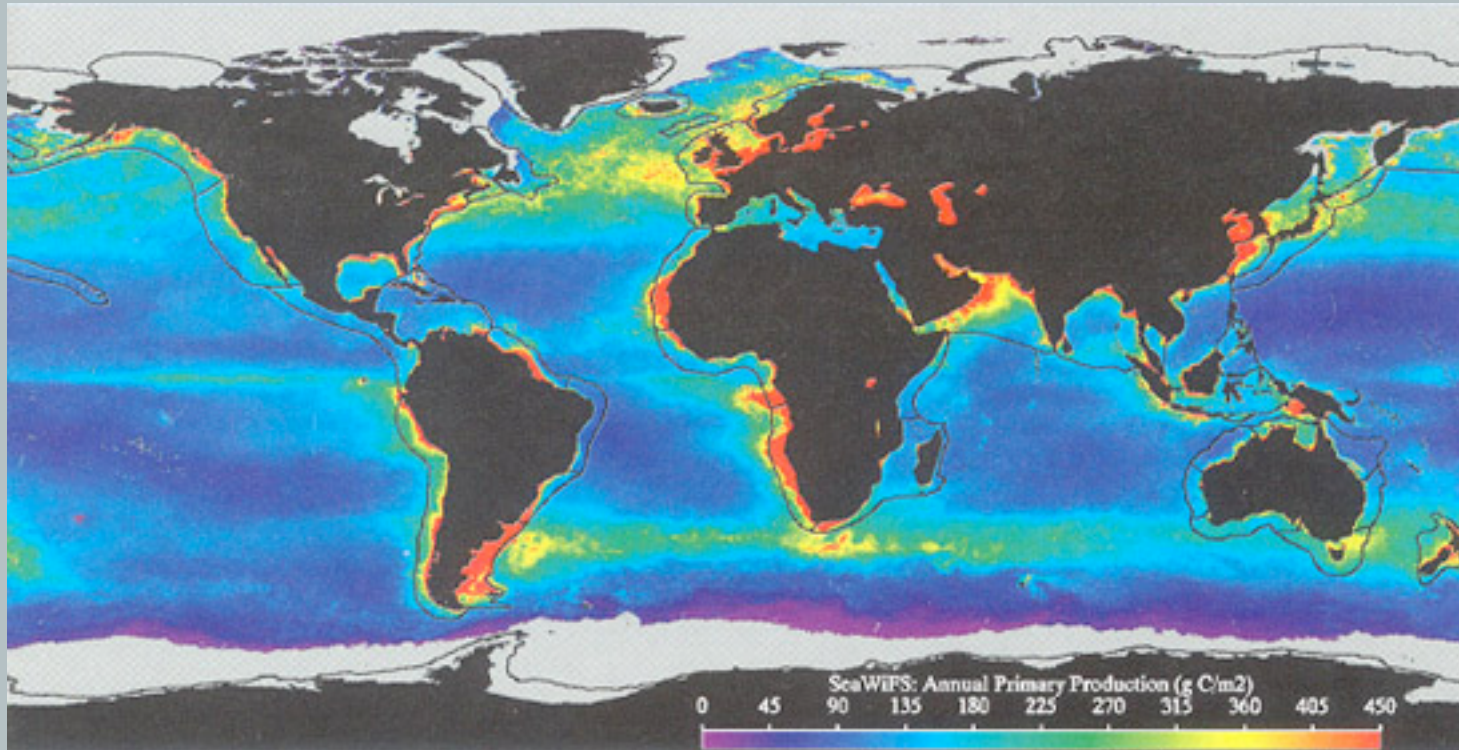


Pelagic Habitat Assessment

- Typically a suite of satellite data, i.e. SSH, SST, ocean color, and wind data, is used synergistically to characterize LMR habitat.
- Marine ecosystems encompass vast areas of the ocean, both coastal and pelagic. The high temporal and spatial resolution of satellite data, as well as its continuity, makes satellite data a crucial component of monitoring and characterizing marine ecosystems.



Large Marine Ecosystems



Average satellite-derived Primary Productivity and the outlines of the 64 defined Large Marine Ecosystems (LMEs)

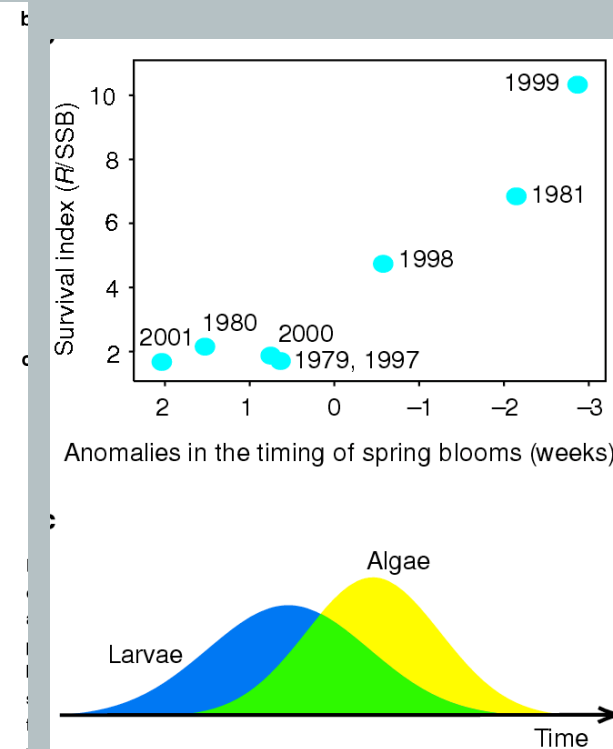
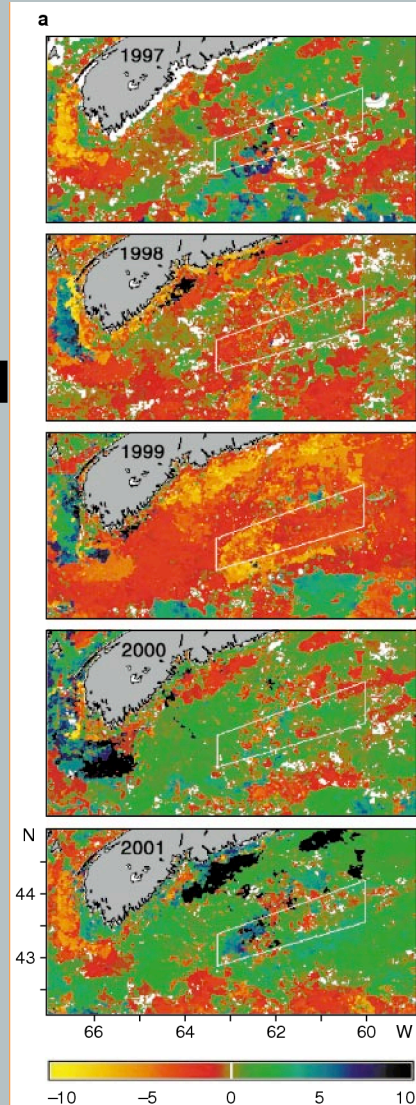
www.wdc.uri.edu/lme





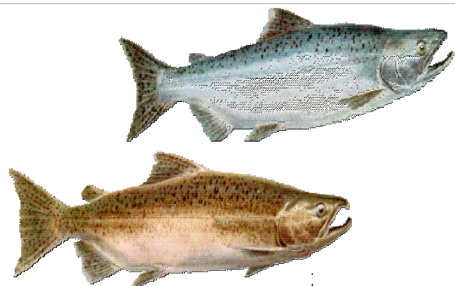
Timing of the Spring bloom and Haddock Survival

Contours of the annual anomaly in the timing of the spring bloom based on SeaWiFS chlorophyll data



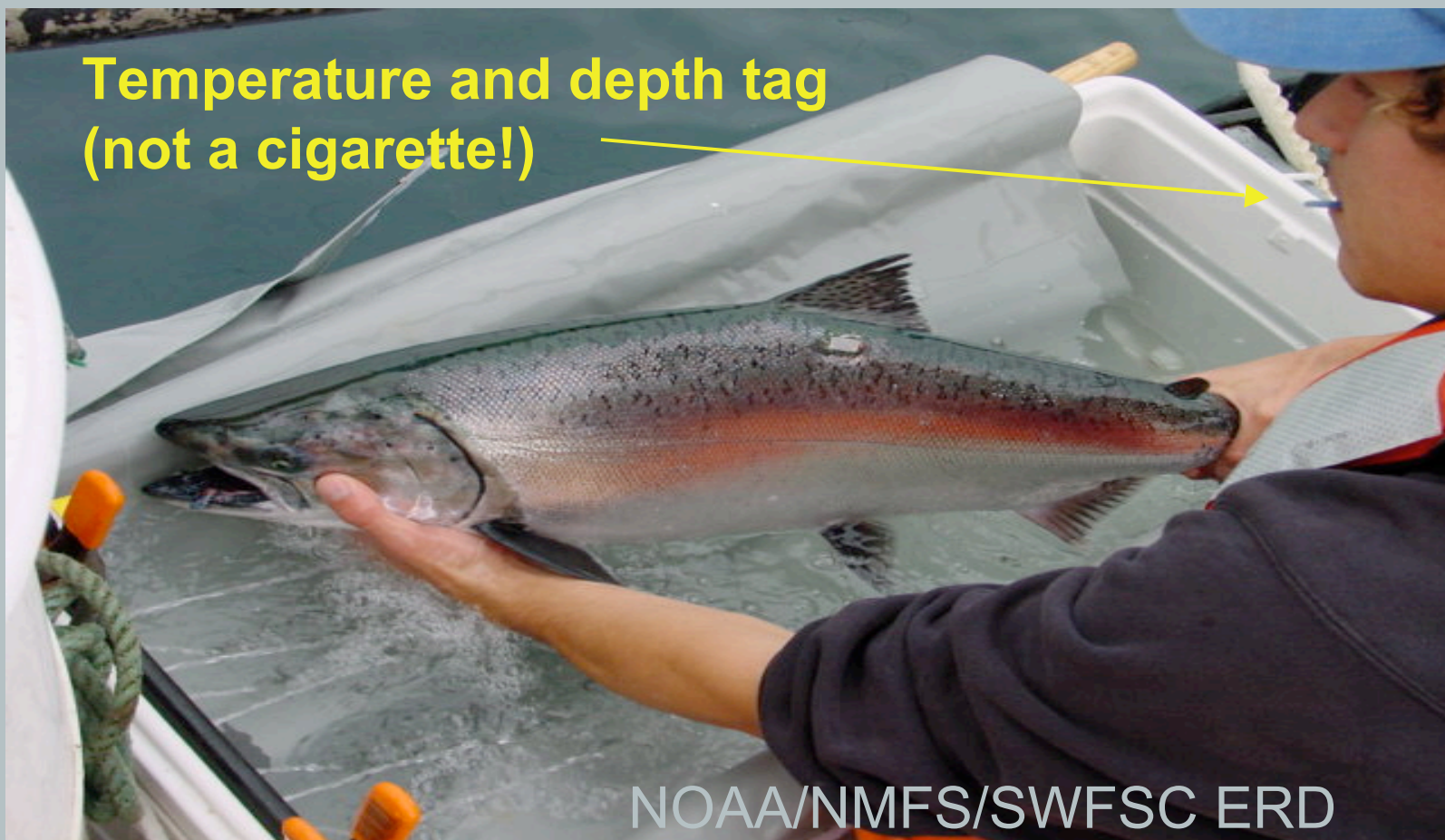
From Platt et al.,
Nature, 2003



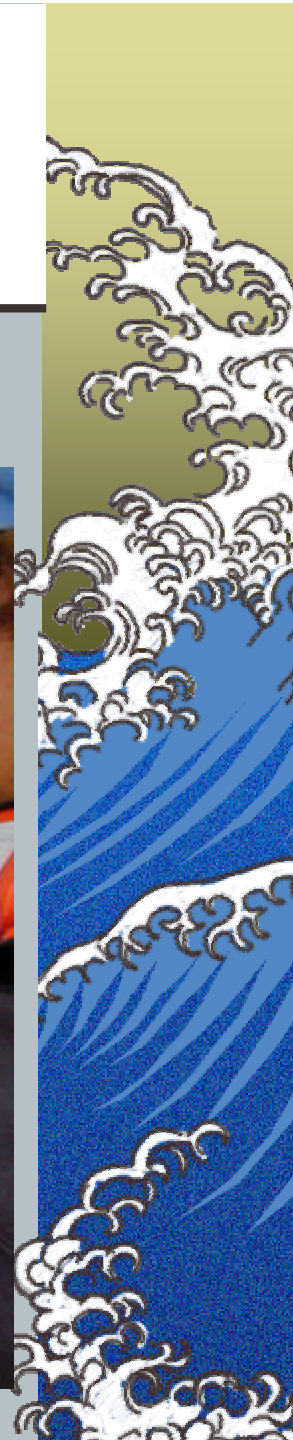


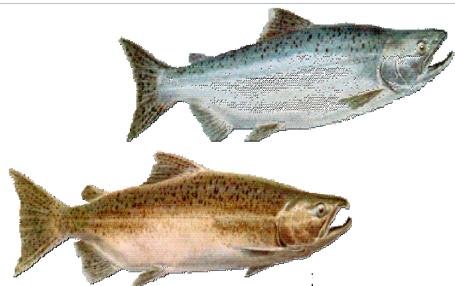
Defining Salmon Ocean Habitat

Temperature and depth tag
(not a cigarette!)

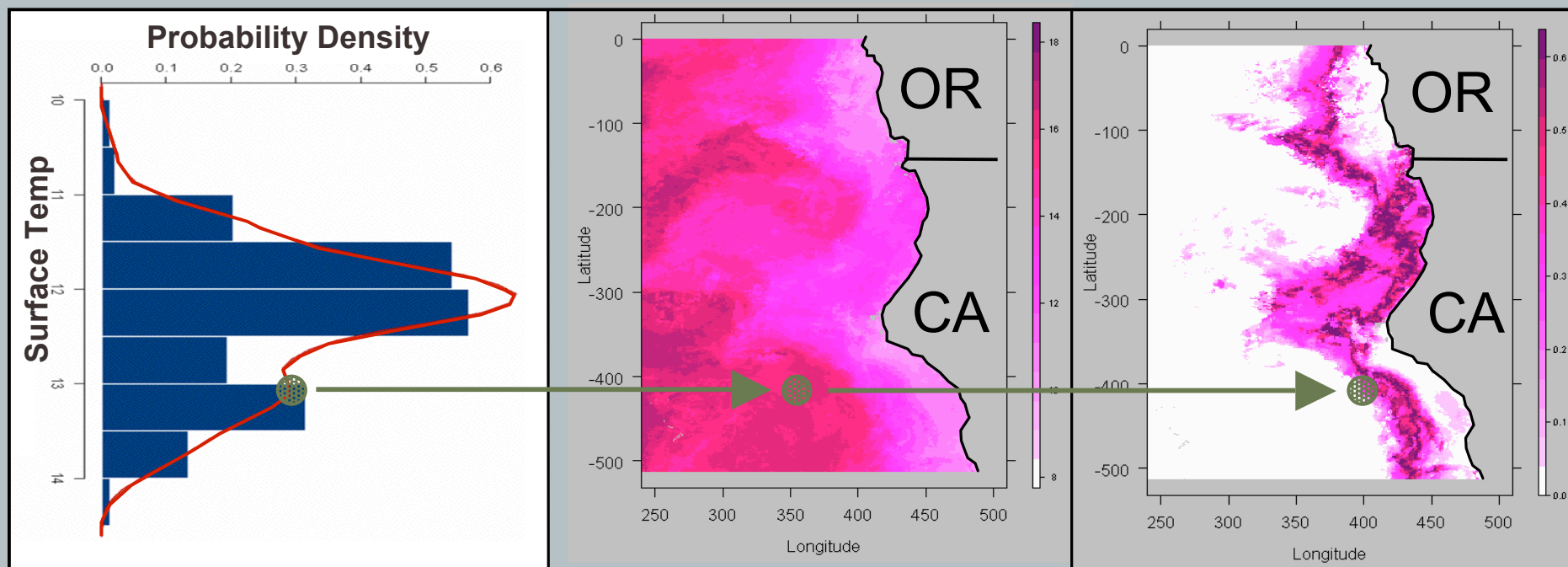


NOAA/NMFS/SWFSC ERD





Chinook Potential Habitat



**Density of fish's
temperature experience
at the surface from tag
data**

Satellite SST

**"Contours of
utilization" – likely
fish location**



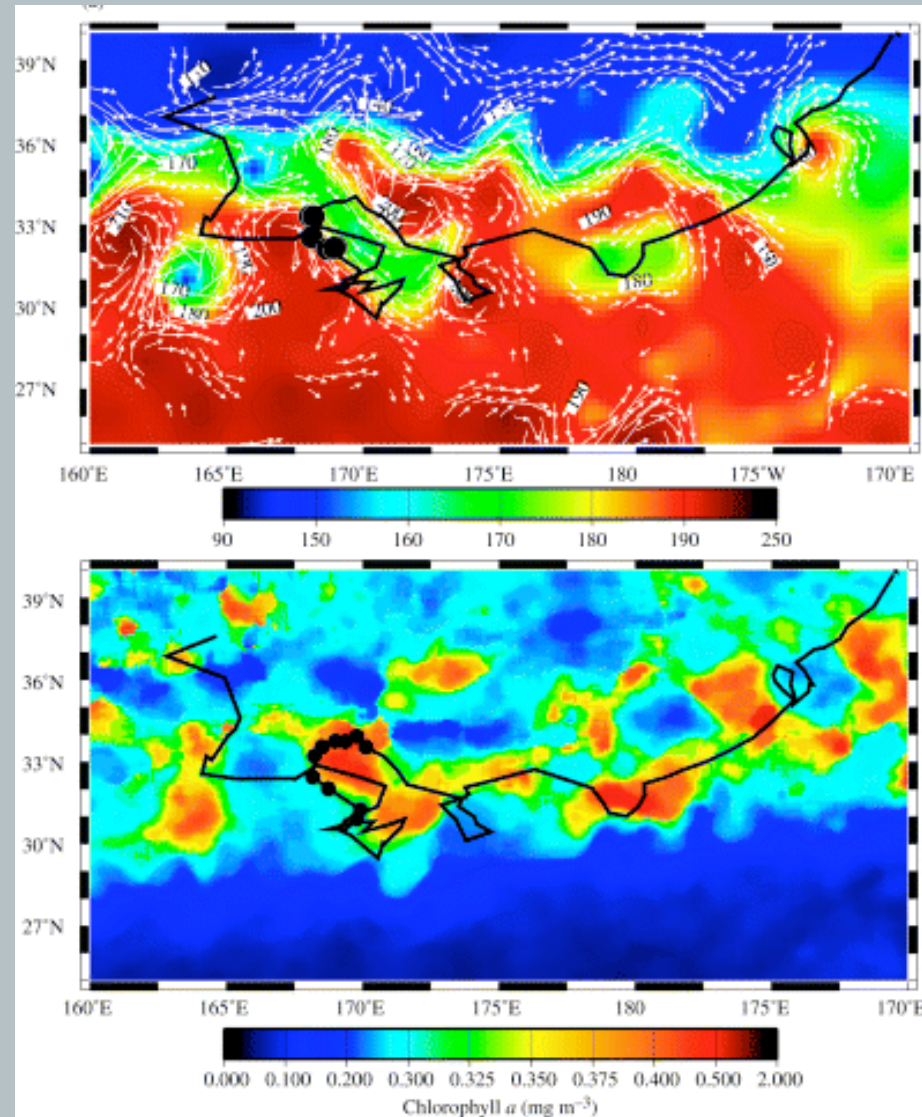
Characterizing Turtle Habitat

SSH

Loggerhead turtle tracks along the TZCF (Transitional Zone Chlorophyll Front) in the North Pacific during Feb. 2001

Chlorophyll

*Polovina et al., Fish. Ocean., 2004
NOAA/NMFS/PIFSC*



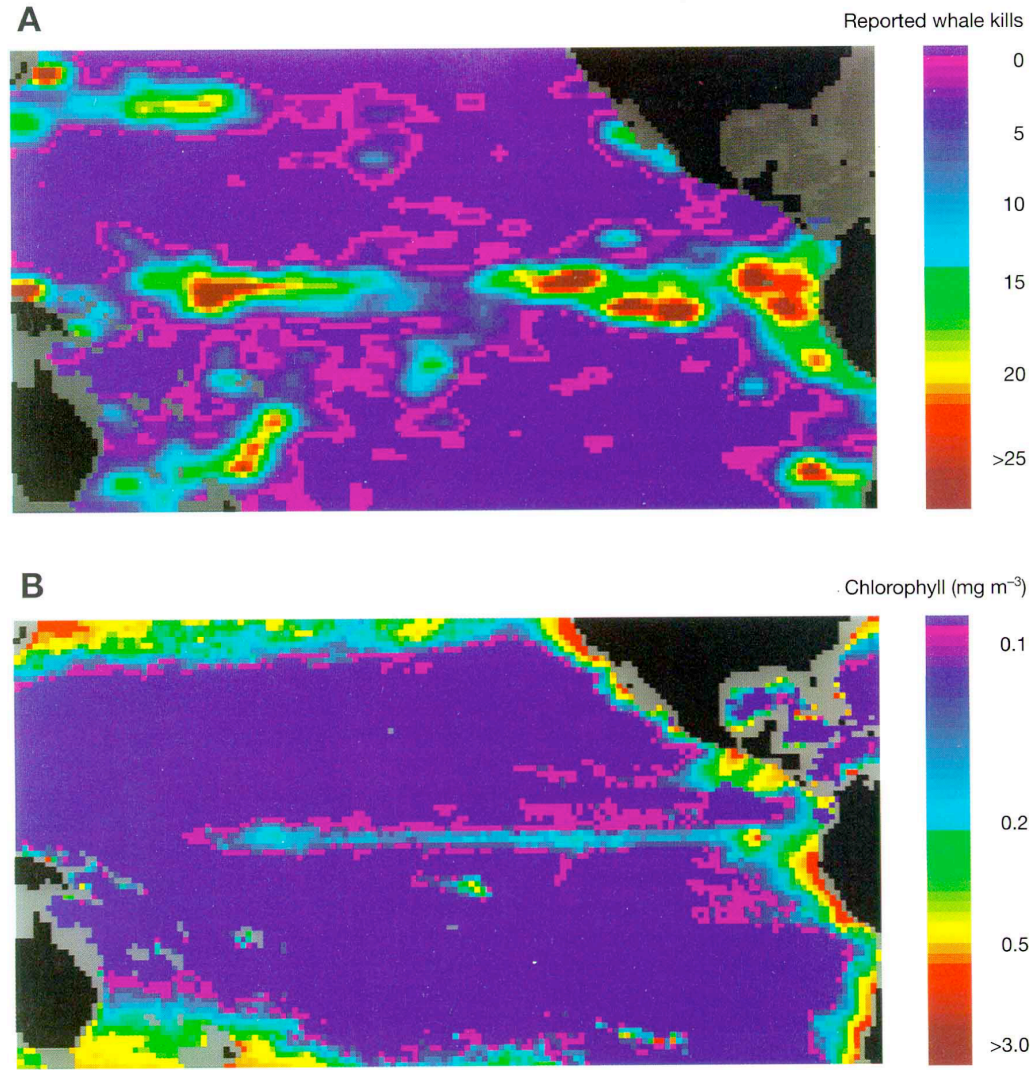


Sperm Whale distribution

**Historical
whale kill
distribution**

**Climatological
CZCS
chlorophyll**

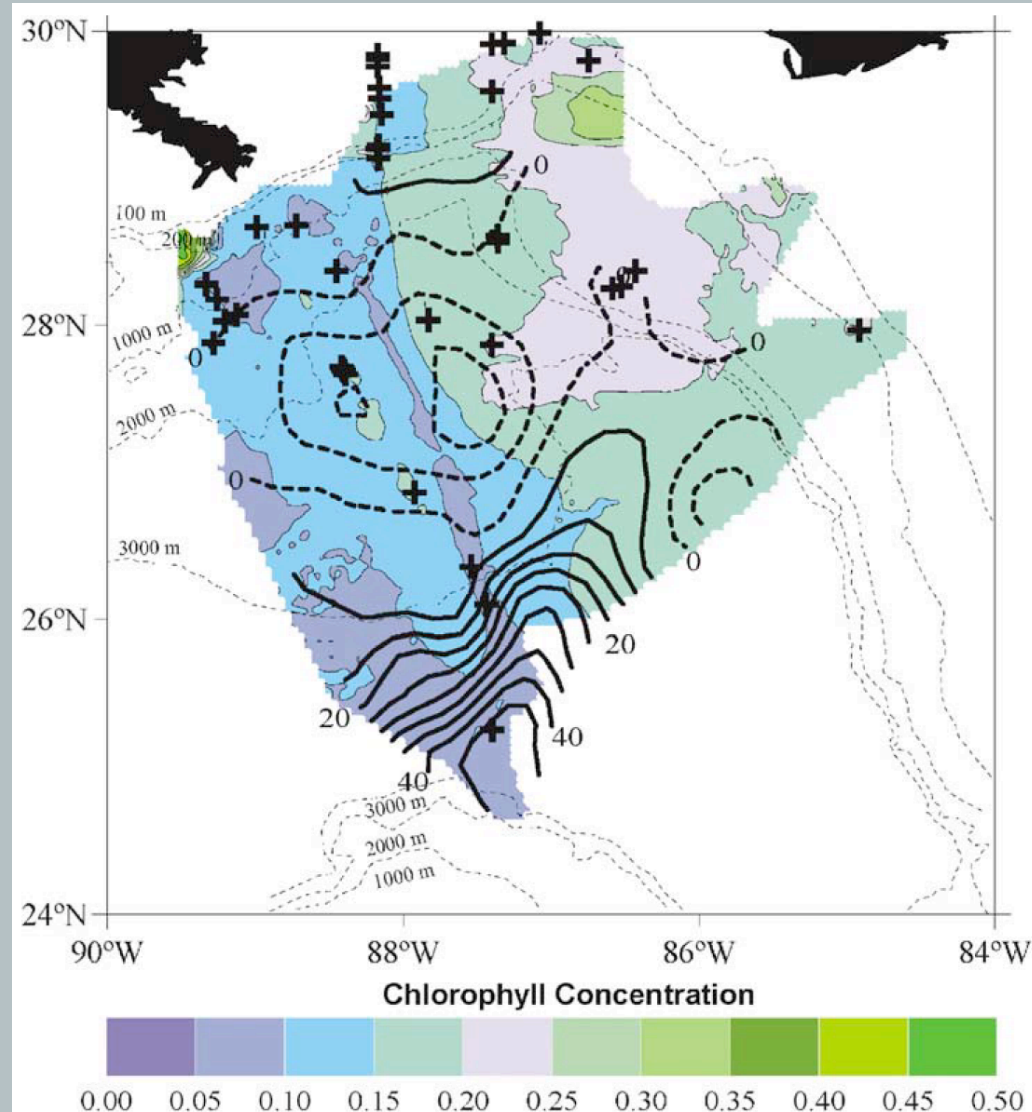
Jaquet et al., MEPS 1996





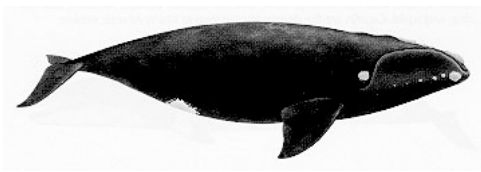
Sperm Whale distribution

Whale sightings (+) overlaid on surface chl (colors) and SSH anomaly (contours) in the Gulf of Mexico

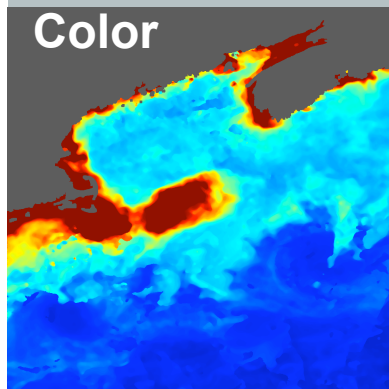


Davis et al., DSR I, 2002

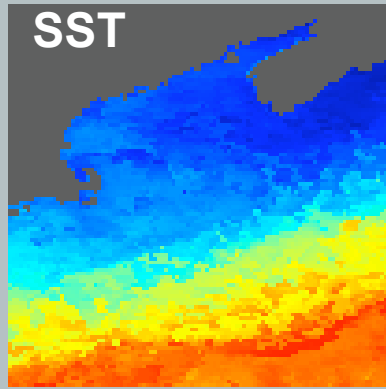




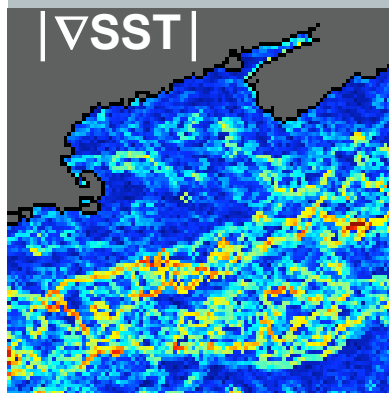
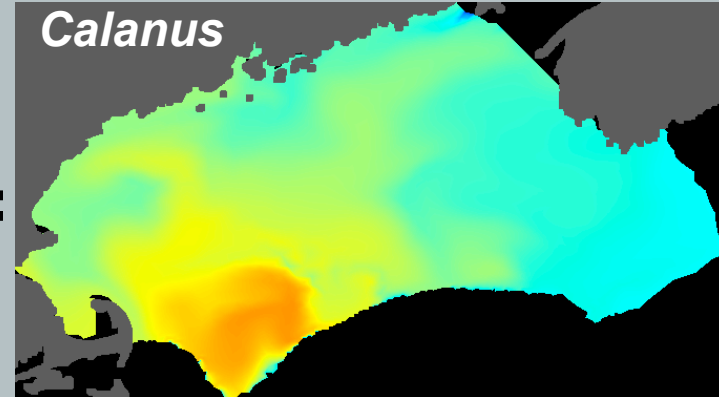
Right Whale Forecast



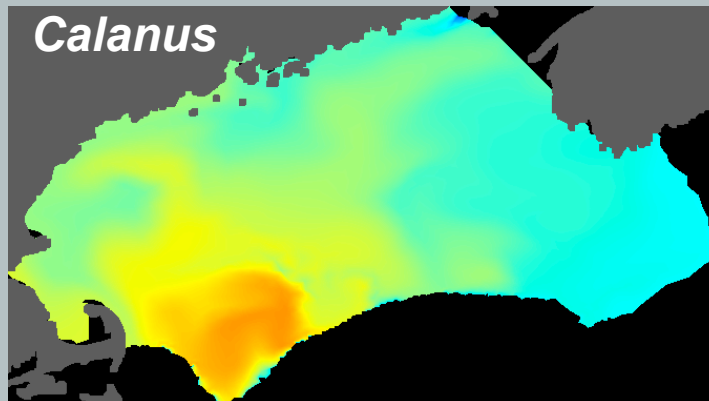
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Whale
feeding
areas

Pershing and Monger, Cornell University

www.geo.cornell.edu/whales

Funded by NOAA's Right Whale Grants Program



Issues...



Ocean



Ocean



The Bottom Line...



- NOAA will be taking over the operational acquisition of major satellite measurements such as SSH, ocean color and surface winds.
- In support of this, NOAA needs to demonstrate the *operational use of these data* within the agency.
- NMFS and NOS are the two NOAA LOs involved with the operational use of oceanic satellite data (ie non weather). *For the open ocean, NMFS is the only LO.*





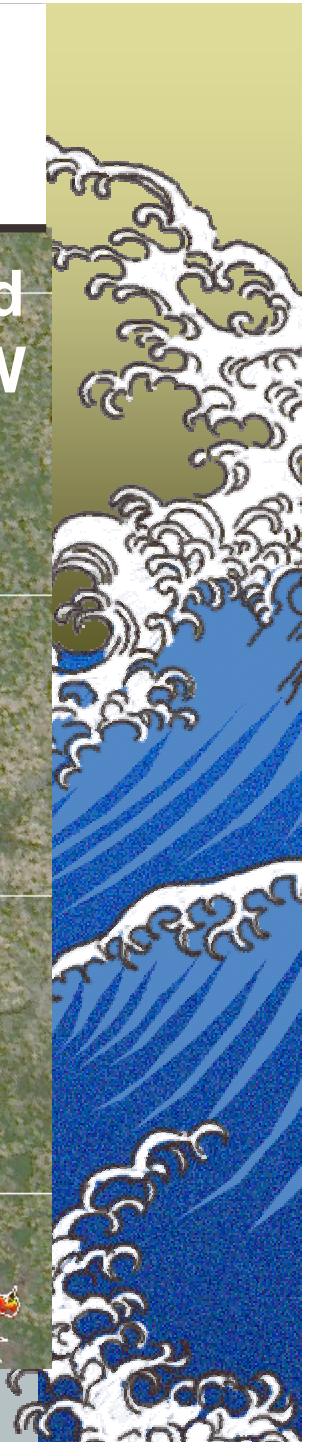
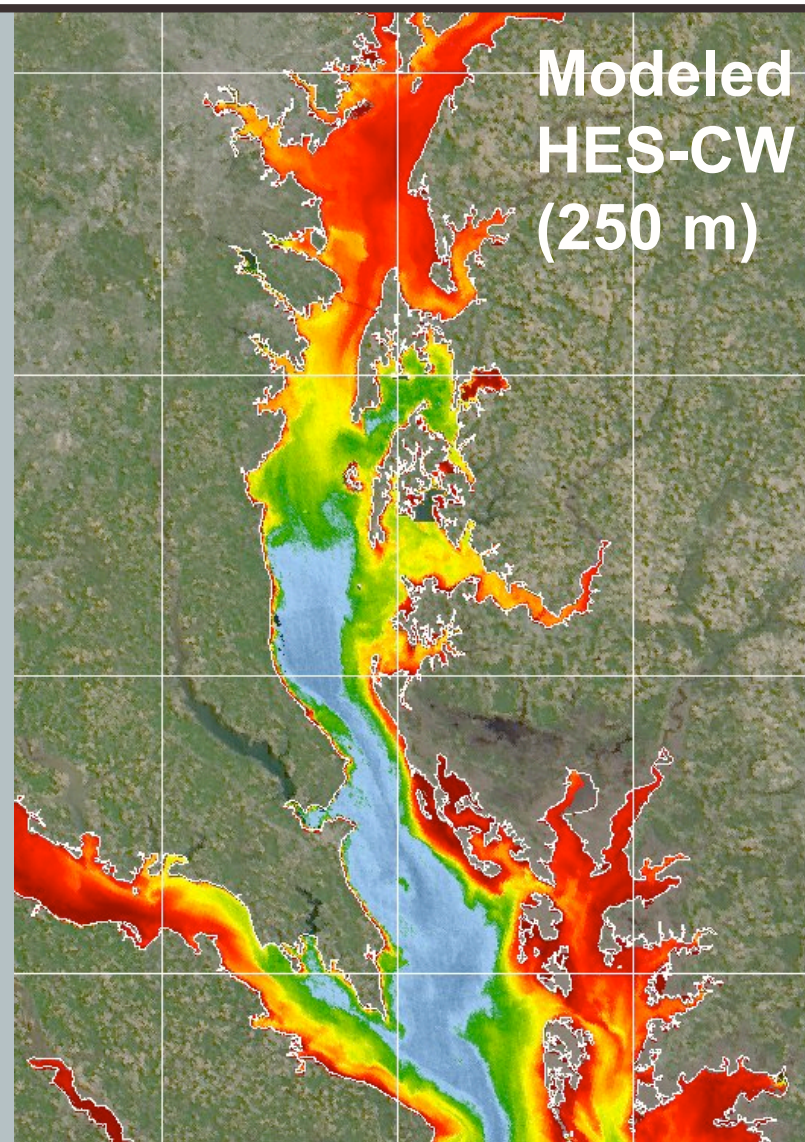
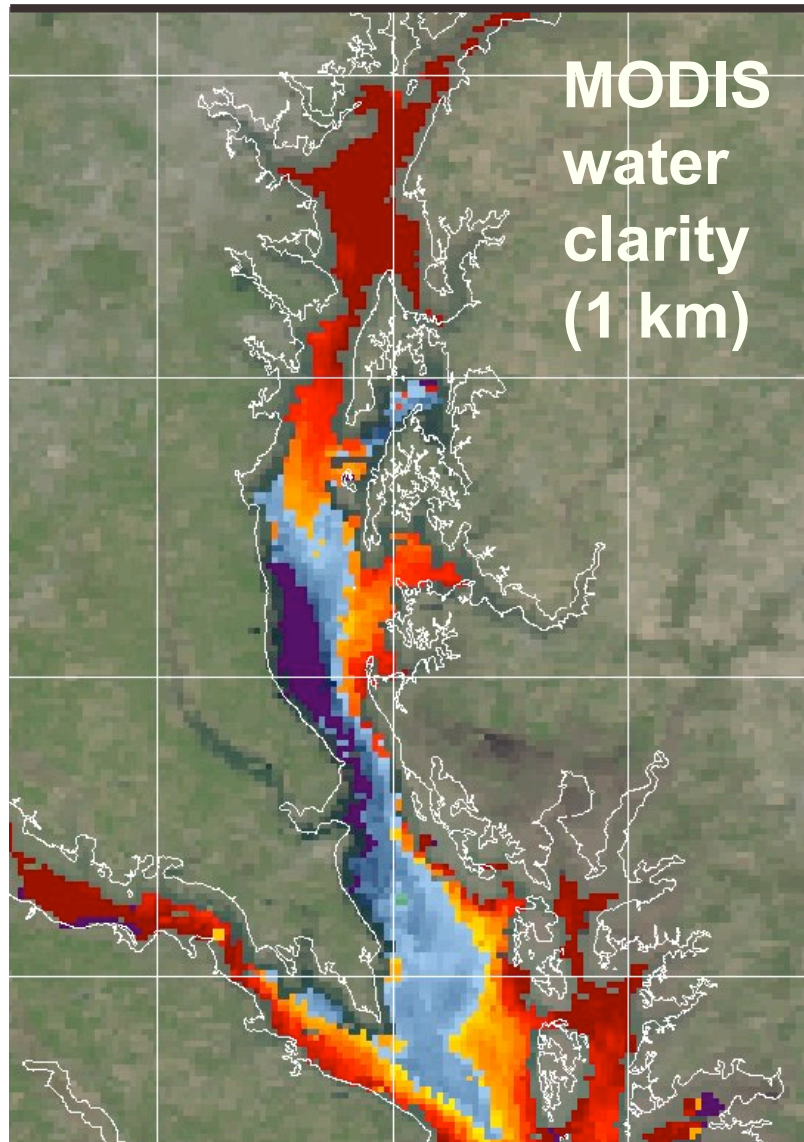
Operational?...



- **“Operational” in the context of fisheries has a different temporal scale than for other uses such as the weather service, HAB monitoring etc.**
- **Linkages between satellite data and ecosystems are indirect, involving subsurface ocean dynamics and long-term climate variability. Understanding and monitoring these interactions requires continuous timeseries of high quality data.**



Spatial Resolution Comparison



Courtesy of the GOES-R COAST team

Better Resolution with GOES-R...

A direct quote responding to the question of what benefits would be expected from the resolution of data from the GOES-R HES-CW:

“Better resolution increases storage constraints, so while better resolution would be useful for select areas where intensive high research is underway, *a global high res dataset would require a great deal more resources to manage...and I am not sure how useful this would be to marine researchers.*”

Meaning ?!?!.....



Better Resolution with GOES-R...

Meaning –

We are currently doing an inadequate job of supplying user-friendly means of:

ACCESS,
MANIPULATION, and
DELIVERY of satellite data

To maximize the utility (and use in an ‘operational’ sense) of satellite data in cross-cutting applications we need to have an efficient system for users to access, manipulate and obtain the satellite data (both real-time and science-quality climate data records).



New CoastWatch Browser at West Coast Node

<http://coastwatch.pfeg.noaa.gov/coastwatch/CWBrowser.jsp>

CoastWatch West Coast Regional
[Home](#) | [Data Browser](#) | [Browser](#) | [Data](#) | [Information](#) | [Software](#) | [El Niño](#) | [Sites](#) | [Feedback](#)

CoastWatch Browser - Create custom maps and download near-real-time satellite data. [[Help](#)]

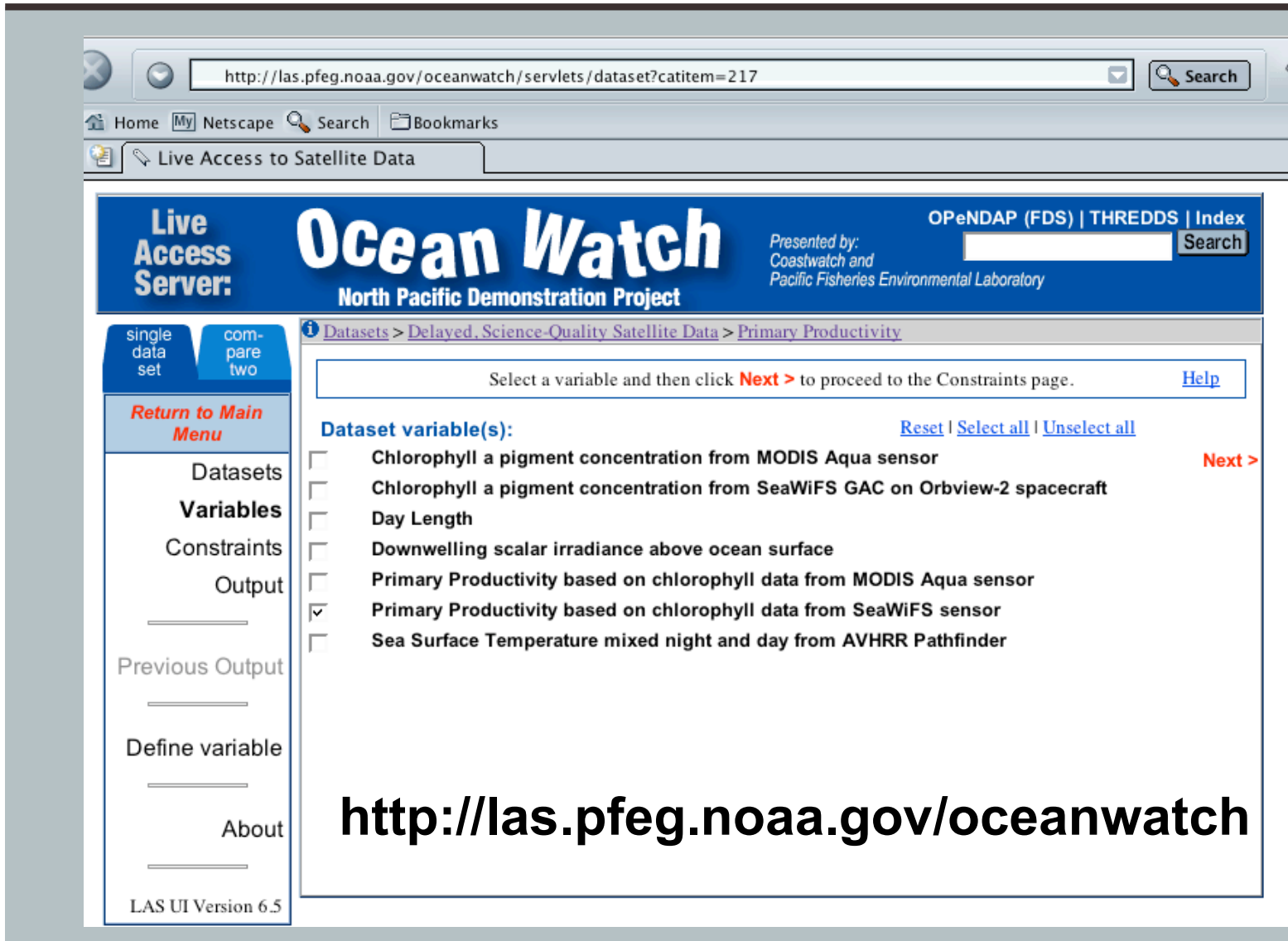
Edit: ☐ The Map ☒ Main Data ☐ Bathymetry ☐ Contour Data ☐ Vector Data

☐ None ☐ SST 1km ☐ SST 11km* ☐ SST Anom.* ☐ Pathfinder SST ☐ GOES SST
☐ Aqua Chl-a ☐ SeaWiFS Chl-a ☐ Zonal Wind* ☐ Merid Wind* ☐ Div Wind*
1) Select a data set: ☒ Mod Wind* ☐ Zonal Wind Stress* ☐ Merid Wind Stress* ☐ Mod Wind Stress*
☐ Stress Curl* ☐ Ekman Upwelling* ☐ Zonal Ekman* ☐ Merid Ekman*
☐ Mod Ekman*

2) Select a time period: ☐ 1 day ☒ 3 day ☐ 8 day

3) Select an ending date: 2005-07-13

Primary Productivity LAS

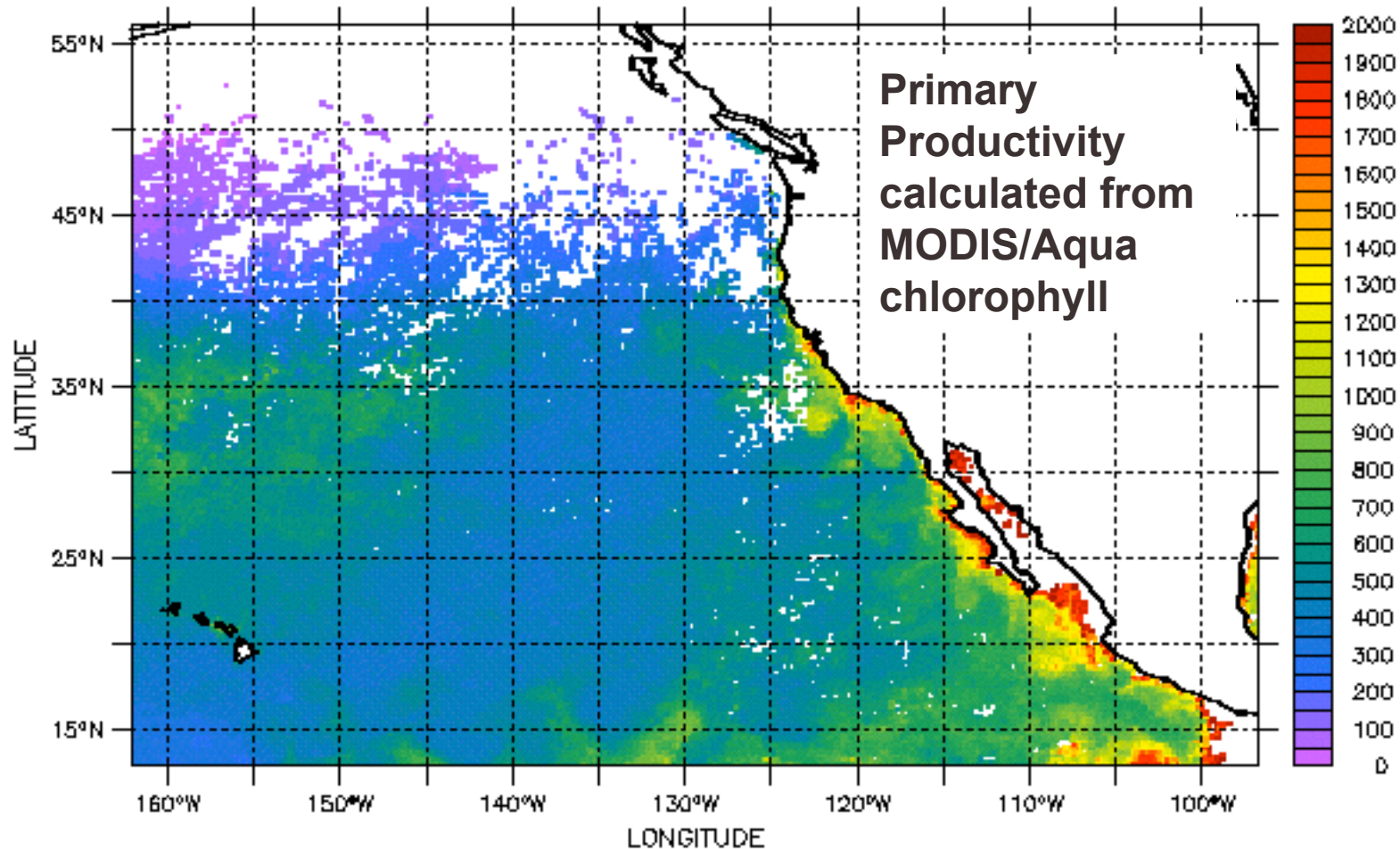


The screenshot displays the Ocean Watch LAS (Live Access Server) interface in a Netscape browser window. The address bar shows the URL: <http://las.pfeg.noaa.gov/oceanwatch/servlets/dataset?catitem=217>. The browser's navigation bar includes links for Home, My Netscape, Search, and Bookmarks. Below the browser window, the Ocean Watch interface features a blue header with the text "Live Access Server: Ocean Watch North Pacific Demonstration Project". To the right of the header, there are links for "OPeNDAP (FDS) | THREDDS | Index" and a "Search" button. A sidebar on the left contains a "Return to Main Menu" link and a list of options: "Datasets", "Variables", "Constraints", "Output", "Previous Output", "Define variable", and "About". The main content area shows the breadcrumb trail: "Datasets > Delayed, Science-Quality Satellite Data > Primary Productivity". Below this, a message states: "Select a variable and then click **Next >** to proceed to the Constraints page." with a "Help" link. A section titled "Dataset variable(s):" lists several variables with checkboxes. The variable "Primary Productivity based on chlorophyll data from SeaWiFS sensor" is selected. To the right of the list are links for "Reset", "Select all", and "Unselect all", followed by a red "Next >" button. At the bottom of the interface, the text "LAS UI Version 6.5" is visible.

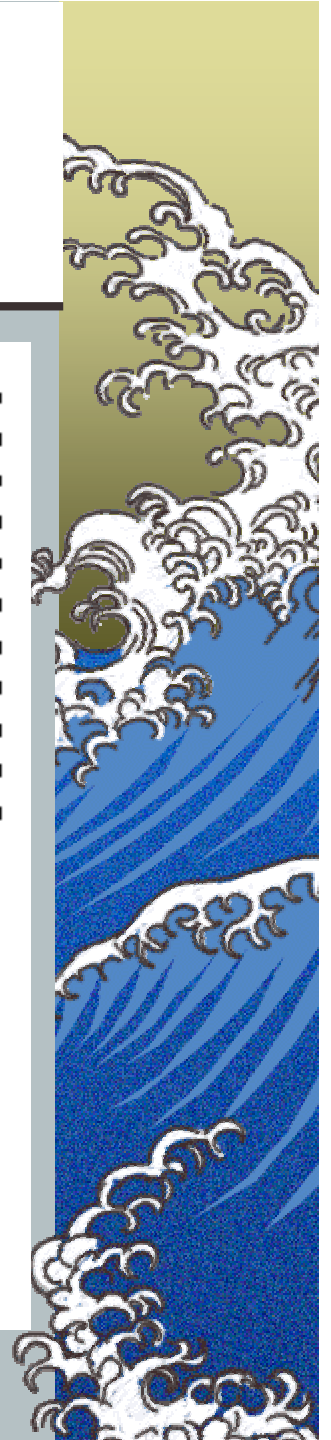
http://las.pfeg.noaa.gov/oceanwatch



Primary Productivity LAS



<http://las.pfeg.noaa.gov/oceanwatch>



Summary Points

- **Need data easily accessible, with the capability to subset and manipulate data before downloading**
- **Primary Productivity**
- **Timeseries of science quality satellite data**

Ocean

Ocean



Thank you...

Fishing down the Food Web

